Theories of Energy

By

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If we would understand all things, we must understand energy, for energy is the cause of all things.

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PREFACE

MORE than twenty years ago I began a study of energy, and in pursuing the subject I have been led into many branches of science, into all those sciences concerning natural phenomena and the processes of nature, and I have studied these things with the idea that energy is the cause ever present in my mind, and have ever sought to understand how the cause produces the effects.

My purpose has been to learn, if possible, something of the nature of energy and of the method in which it acts in matter, and after all these years of study I feel confident, in the light of the knowledge I have gained, that my labour has not been in vain.

Of one thing at least I am certain, and that is that all atomic matter is perpetually energetic within itself, and that the energetic

condition of each part is affected by the energy of other parts.

On no other hypothesis can the phenomena and processes of nature be explained, and when we have come to a realization of the truth of this hypothesis, as we undoubtedly shall, a great advance will have been made toward a true understanding of nature in all her marvellous works.

In considering what the form of action in energetic matter is we must depend entirely upon logical reasoning, because the motion of the matter defies detection, and probably will ever defy detection; but we are not left without hope, for the effects are many and ever present, and by studying them assiduously and analyzing them carefully we may, by reasoning logically, arrive at a reasonable conclusion as to the nature of the cause, taking into consideration the qualities which we know matter to possess.

In this way I have arrived at what I consider to be a reasonable conclusion as to the character of energial action, and as to

the methods by which the different effects are produced.

The results of my thoughts and investigations are set forth in these pages, given as theories.

It has been my aim to be explicit and concise, and in order to facilitate the treatment of the subject and make myself the better understood, I have found it necessary to make use of a number of new terms.

H. P.

SAN FRANCISCO,
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Theories of Energy

CHAPTER I

THE THEORY OF ENERGIAL PROPAGATION

(The figures in parentheses refer to notes in the back part of the book.)

ALL space is filled with matter, and in the infiniteness of space there is no vacuity anywhere, not even of the extent of an atom's size, and the universe, embracing all the matter in existence, is continuous throughout. Such is the integrity of the universe.

That energy is transmitted between the bodies of the universe is indisputable, and energy being a condition of matter, since there cannot be a condition of matter where

there is no matter, we must take it that space is filled with matter, ethereal and atomic, and we are justified in considering that the ether is the medium through which energy is transmitted between the bodies of the universe, and the transmission or propagation of energy through the ether is the subject to be considered in this chapter.

Under the prevailing theories, the undulatory theory and the electro-magnetic theory, which are theories of energial (1) propagation or action through the ether, it is necessary to assume that the ether possesses certain physical qualities, solidity and elasticity, which would necessitate cohesion between its parts, so that they would cling together tenaciously, but the fact that the ether offers no resistance to the planets and satellites in their passage through it, precludes the idea that it possesses any such qualities.

The ether is, in all probability, a homogeneous substance, not in the form of particles, as some consider, but unparticulate (2)

and continuous, and it is only reasonable to suppose that there is no cohesion between its parts, there being merely a togetherness without any forcible hold.

Having no cohesion between its parts, it cannot have solidity nor elasticity. Having no solidity, it is a perfect fluid, and being a perfect fluid, it has perfect passability, offering no resistance to the passage of bodies through it.

The ether has density, because it occupies space, density depending upon the quantity of matter in any space, and its density must be uniform throughout its infinite expanse, because, being a perfect fluid, a uniformity of density must obtain. It is impossible to say what its density is, and it is immaterial, since passability depends on fluidity alone. Mercury has much greater density than cork, and yet, due to its fluidity, it has much greater passability than cork.

We know that the ether has a remarkable power of transmitting energy, and if we are able to explain this without the necessity of

ascribing to it the quality of solidity, the explanation will assuredly be the more acceptable.

Under the theory of energial propagation here advanced it is considered that the ether is condensable and rarefiable, and that, owing to its perfect fluidity, when it is condensed at any point, the dense condition is immediately taken up by the surrounding ether, the density of the ether in all directions and for a great distance becoming enough greater to equalize the density throughout, and that when it is rarefied at any point, the rare condition is immediately taken up by the surrounding ether, the density of the ether in all directions and for a great distance becoming enough less to equalize the density throughout.

The equalization of density necessitates a slight movement of matter. In the case of condensation the movement of matter is away from the point of condensation, and in the case of rarefaction the movement of matter is toward the point of rarefaction.

While the movements of matter in the two cases are in opposite directions, the equalizing actions in both cases, whereby the dense and rare conditions are taken up and the density equalized over a great distance, proceed away from the points of condensation and rarefaction, and the equalization takes place with the same speed in both cases, so that if, after one action has set in, the opposite action sets in from the same point, the latter does not overcome the former.

Of course the ether cannot become more dense at one point without becoming less dense at another point at the same time, because matter must move to the point of condensation from some other point, and we therefore see that every equalizing action of a dense condition must be accompanied by an equal equalizing action of a rare condition.

It is quite clear that either action may precede the other, and it is clear that a succession of equalizing actions of the two kinds,

originating at the same point, as we may say, the points of origin being proximate, may occur in the ether, the actions resulting from condensation alternating with those resulting from rarefaction, each action resulting from condensation being followed by the action resulting from the accompanying rarefaction, or vice versa, so that between two actions of the former kind there will be an action of the latter kind, and between two actions of the latter kind there will be an action of the former kind, just as between two waves on the ocean there is a trough, and between two troughs there is a wave.

By way of illustration let us suppose that we have a bottle filled with compressed air. The air in the bottle being denser than the outside air, if the bottle be broken the dense condition will be immediately taken up by the surrounding air, and the density of the air for a great distance around in all directions will be increased in the equalizing process. Also, if we break a bottle from which the air has been exhausted the vacuum will

be immediately taken up by the surrounding air, and the density of the air for a great distance around in all directions will be decreased in the equalizing process.

In each case the action whereby the density is equalized will proceed away from the bottle, and the equalizing actions in both cases will be propagated at the same speed, and in either case, after setting in, the equalizing action will continue on even though an equalizing action of the opposite kind should shortly afterwards set in at the same point, so that if an evacuated bottle be broken shortly after the breaking of a bottle containing compressed air, the equalizing action resulting from the vacuum will not stop the propagation of the preceding action, and if, after the equalizing action resulting from the vacuum has set in, another bottle containing compressed air be broken, the equalizing action resulting therefrom will not stop the propagation of the equalizing action resulting from the vacuum, so that the two kinds of equalizing actions may

follow each other in rapid succession without interfering with the propagation of each other.

The equalization of density does not occur simultaneously at all the points to which it extends in the medium, but it is accomplished by the propagation of a certain action, and the propagation of such action necessarily takes time, for it must occur at one point before it reaches another point. It is for this reason that a subsequent equalizing action does not stop the propagation of a preceding action of the opposite kind, the two being propagated at the same speed.

Now, under the theory it is supposed that energy is transmitted or propagated through the ether (and through other transmitting media also) in the manner described, it being supposed that the alternate dense and rare conditions in the medium are caused by the energy of atomic matter, and that they in turn cause energy in atomic matter which they engage.

The dense and rare portions of the medium,

occurring alternately, since they depend on difference in the density, may be called Densits (3), and for the purpose of distinguishing the two kinds and identifying them with the two qualities of energy, positive and negative, it being supposed under the theory that all forms of energy have two qualities and that the two qualities are transmitted together, the dense portions may be called Positive densits, and the rare portions may be called Negative densits.

The densitic intensity depends on the degree of density in the positive densits and the degree of rarity in the negative densits, and the densitic intensity determines the intensity of the energy.

Since rarefaction results as a consequence of condensation, or vice versa, the degree of rarity is exactly equal to the degree of density in any case, so that in a densitic system the intensity of the negative densits is exactly equal to the intensity of the positive densits, and so the two qualities of energy in any system are exactly equal in intensity.

It is clear that in the equalization of density the intensity diminishes inversely as the squares of the distances over which the action proceeds, which means that the densitic intensity varies inversely as the squares of the distances over which the densits proceed, and therefore the intensity of the transmitted energy varies in the same manner.

If the densits originate at a single, isolated particle of atomic matter in the medium they will proceed in all directions from it, and, the medium having uniform density, they will be propagated at the same velocity in all directions, so that each densit will be spherical in form, and all will be concentric and parallel.

But energy is usually transmitted from points in the surfaces of bodies of atomic matter, and the form of the densits which are propagated through the medium from the points in the surface of a body is that of some segment of a sphere, being hemispherical when they originate at points in a convex or plane surface.

Densits are often deformed through refraction, losing the spherical form and taking some other convex form, such as the form of an ellipsoid, or some segment thereof, or becoming plane or concave, the convexity being reversed. When brought to a focus by a lens they are always concave, and after passing the focal point they become convex again.

Each little part of a densit proceeds along a line which is normal to that part of the densit, and this principle of normal propagation obtains whatever the densitic form. If the form is spherical the parts proceed along lines radiating from the point of generation. If the convexity is reversed the parts proceed along lines converging to the focal point. If the form is that of a plane the parts proceed along parallel lines.

In such cases the lines of propagation are straight, but when the density of the medium is not uniform the lines of propagation are curved, as, owing to the non-uniformity of density of the earth's atmosphere, the lines

of propagation through it of the angling sunlight and starlight are curved, on which account we see them at rising sooner than we otherwise would, and we see them at setting later than we otherwise would.

The densits proceed through a medium at a high velocity, and the densitic velocity is the velocity at which the energy is transmitted. The velocity is different in different media, and it is different in the same medium at different densities, the more dense the medium, the lower the velocity.

By this theory of energial propagation we are enabled to understand how the two qualities of energy, positive and negative, are transmitted together through a medium, the positive densits being the positive energy, and the negative densits being the negative energy. This theory of biqualital (4) transmitted energy is supported by the experiments of Sir J. J. Thomson (5).

Under the theory of kinetic energizement, explained in a subsequent chapter, the positively charged particles referred to by Prof.

Thomson are actuated in one direction by the positive energy, and the negatively charged particles are actuated in the opposite direction by the negative energy.

Under both the undulatory theory and the electro-magnetic theory the ether is considered to be the only transmitting medium. It is more reasonable to suppose that energy is transmitted through atomic matter also, and the transmission of energy through atomic matter will be considered in a subsequent chapter.

CHAPTER II

THE THEORY OF THE ENERGETIC ATOM

UNDER the prevailing theory of energy the particles of atomic matter are not supposed to be energetic within themselves. It is supposed that the particles are not in contact with each other, but that there are spaces between them filled with ether, and it is supposed that the waves in the ether enter these spaces and cause the particles to oscillate or fly around, which motion of the particles is supposed to be the energy of the atomic matter (6).

Under the theory of the energetic atom here advanced it is supposed that the atoms are composed of unparticulate matter, and it is supposed that the matter composing the atom is energetic within itself.

Vision is undoubtedly due to the energy which is transmitted to the eye from the matter perceived, and when we consider that we can see from any direction above the surface of a piece of white paper every point in the surface, we must suppose that the transmitted energy is generated at every point in the surface, and the fact that we can see each point from every direction above the surface indicates that the densits are hemispherical in form, which shows that the systems of densits must originate at the points of which they give vision, respectively.

The prevailing idea is that vision of an object depends on the light which is broken up by irregular reflection, due to the roughness of the surface, and scattered in all directions (7), but when we consider that the densits which give vision of any point in the surface of an object must be perfectly regular throughout and continuous throughout, the theory becomes untenable. And especially does the theory become untenable when we consider that the densitic curvature (8) of

the light by which we see the points in the surface of an object near at hand is greater than that of the regularly reflected sunlight from such surface, shown by the fact that the focal point in the eye for the densits which give vision of objects near at hand shifts with the changing of the distance between the eye and the object, requiring an adjustment of the lens, which is not the case with regularly reflected sunlight or light from a distant source, because, owing to the great distance of the sun, the comparatively slight changes in distance have no appreciable effect on the densitic curvature. If the densits which give vision of objects in the sunlight were formed by irregularly reflected parts of the sunlight, the densitic curvature would be the same as in the sunlight regularly reflected from the objects, and the focal point in the eye would be the same at all distances.

We must therefore conclude that the energy which gives us vision of the objects about us is generated by the atoms in the surfaces of

the objects, the atoms being incited to energy by the light which falls upon them.

Without a microscope a very small particle of matter can be seen, so small that it appears to be a bare point without appreciable expanse, and no surface details can be seen, but when we look at the particle through a microscope of high power it appears to have quite an expanse, and many points, many thousands of points, can be seen in its surface, and surface details, even differences in colour, can be seen.

The densits generated at the different points in the surface of the particle are so nearly parallel that without the microscope they reach a single cell in the retina. The microscope increases the densitic angularity (9), so that they reach different cells in the retina, and at the same time it decreases the densitic expanse, thereby increasing the intensity and making the vision stronger.

From this we see how small the particles of matter are in which the densits are generated, and this, together with other facts,

justifies us in saying that the atoms are individually energetic.

Contrary to the idea held under the present theories of atomic matter, it is supposed that the atoms composing a body are in contact with each other, with cohesion between them, so that they cling together, for it is unreasonable to suppose that a body could maintain its form and its integrity without cohesion between the atoms, and it is inconceivable that a body could have rigidity and elasticity without the particles firmly cohering together.

Under the theory different kinds of atoms are supposed to have different densities and different degrees of solidity. The hydrogen atom is supposed to be tenuous, with very little solidity, and the iron atom is supposed to be dense, with great solidity.

As is well known, different atomic substances manifest different energial characters, being differently affected by energy, having different colours, transmitting energy differently, and so on, and under the theory it is supposed that the energial characters are

due to the physical conditions of the atoms, for under what may be called the Law of Conditions, which seems to be the prime law of nature, different effects occur under different conditions.

Under the theory it is considered that every atom possesses the inherent power of energy, and that every atom is eternally energetic within itself. It is supposed that the internal energy acts toward or away from the centre of the atom, probably toward the centre in some, and probably away from the centre in others.

Considering the energy to be biqualital, and considering the action to be the same as that whereby energy is transmitted through a medium, as explained in the preceding chapter, consisting in the occurrence of alternate dense and rare conditions, and giving rise to both positive and negative densits, it is supposed that the densits proceed toward the centre of the atom or away from the centre of the same, the positive movement of matter being in the direction

in which the densits proceed, and the negative movement of matter being in the opposite direction.

It is a remarkable fact that different kinds of atoms may be combined together in a compound and that they may then be separated or dissociated by chemical reaction without losing their individual identities. The dissociation is accomplished through the energy of the atoms themselves, and under the theory that each atom is energetic within itself it is easy to understand how it maintains its individuality, for, the energy of each atom acting either toward or away from its centre, as the case may be, the centres of adjacent atoms are definitely established centres of energy, and when the condition of energy which causes the dissociation arises in the atoms, each of course maintains its individual integrity.

While it is considered that the atom is eternally energetic, it is clear that its energy may be augmented and retarded. All the matter of which we know on the earth has

temperature, and we know that the temperature of all matter may be raised and reduced, which means that its energy may be augmented and retarded.

Gravity is undoubtedly a form of energy, and under the theory it is supposed that every atom is perpetually energetic in that form of energy.

The temperature of all the atomic matter of which we know on the earth is far above absolute zero, and under the theory it is supposed that bodies of atomic matter are perpetually energetic in the heat form of energy, and also in the form of energy which causes chemical action, the gamma energy of radioactive matter being of that form; these forms of energy arising in consequence of the existence of many atoms together.

Radioactivity is an energetic condition of matter, and it is said that all atomic matter is radioactive (10).

If we suppose that the energy acts toward or away from the centres of the atoms, the movement of matter in one of the qualities

of the energy is toward the outskirts of the atoms, and we can well imagine that small parts of the atoms might easily become separated at the outskirts, and the atoms be thereby gradually disintegrated, it being the opinion of physicists that the atoms are disintegrated by radioactivity (11).

Under this theory it can be understood how the process may continue over a long period of time without the atoms being entirely disintegrated, for it is to be supposed that the diffusion is commensurate with the size of the atom, so that as the atom decreases in size, the diffusion decreases accordingly, and, theoretically, at least, no matter how long the process might continue, the central portion of the atom would still remain.

Under the theory the size of the atom has little or nothing to do with its character, its character depending upon its physical and energial peculiarities.

Under the theory it is supposed that condensation and rarefaction in an atom give rise to densition, positive and negative, in the

atom, the propagating action in the atom being similar to that which is supposed to occur in the ether, as explained in the preceding chapter, and it is supposed that the condensing and rarefying actions are perpetually recurring in the atom, due to an inherent power.

The propagation of energy in atomic matter is evidently affected by the physical condition and physical qualities of the matter, the elasticity of the matter, especially, having to do with the velocity of propagation.

CHAPTER III

THE THEORY OF ENERGY

UNDER this theory energy is the action of atomic matter within itself, energy being generated within the atoms. All energy is supposed to be the same in form of action, the form of action being densitic, as has been explained (12).

All energy is transmissible through the ether, and, more or less, through atomic matter also, but until it acts in some method on atomic matter, transmitted energy does not produce any effect by which it can be detected.

The action of the transmitting matter is energy, of course, but it is better to look upon it as the energy of the matter in which it is generated, and from which it is transmitted. We do not refer to the energy which is gen-

erated in the sun and transmitted by the ether as the energy of the ether, but we refer to it as the energy of the sun.

The different forms of energy, gravity, magnetism, heat, light, chemicity (13), and electricity, are differentiated, as far as they are different, by densitic differences, and are manifested as different forms by the different effects produced in matter acted on by them, and under the theory it is supposed that the different effects are due to the different methods of action, on account of the densitic differences which differentiate the different forms.

Under the theory gravity is supposed to be the primordial energy, inherent and perpetual in every atom, and the atoms of bodies and aggregations are also supposed to be perpetually energetic in heat energy and in chemic energy as a consequence of the action of the energy of the atoms on each other, and it is supposed that all energy, except gravity, depends on the action of the energy of the atoms on each other.

Under the theory it is supposed that the

different kinds of atomic matter have different energial characters, or energitias (14), on account of which they become energetic in different ways when incited by the energy of other matter, and on account of which the same matter becomes energetic in different ways when incited by the energy of different kinds of matter.

THE DIFFERENTIATING FACTOR IN ENERGY. It is obvious that the number of densits generated each second in a densitic system depends on the frequency of the condensations and rarefactions at the point of generation, and it is obvious that the distance between two adjacent positive densits, or between two adjacent negative densits, depends on that also and on the velocity which the densits have in the medium through which they are proceeding.

The frequency of generation of the positive densits, or of the negative densits, or the frequency with which the positive densits, or negative densits, arrive at any point, the densits having been generated at the same

point, is the densitic Frequency. The frequency of course depends upon the number of densits generated per second, the second being the unit period of time used in connection with densitic frequency.

The time elapsing between the generation, or between the arrival at a point, of two positive densits, or of two negative densits, is the densitic Interim. This is merely another way of referring to the frequency, because the frequency depends on the interim, but it is a convenient term in connection with densitic generation.

The distance between the centres of two adjacent positive densits, or between the centres of two adjacent negative densits, in a system of densits generated at a single point, is the densitic Interval.

The densitic frequency is the factor to be considered in connection with differences in energy and in connection with the different forms of energy, the differences being due, evidently, to differences in the frequencies of the densits.

While a certain interval corresponds with a certain frequency in one medium, in another medium the same interval does not correspond with the same frequency, because the densitic velocity is not the same in different media. With a given interim, the higher the velocity, the longer the densitic interval, but regardless of the different velocities in different media, and therefore regardless of the different intervals resulting from such different velocities, the energy remains the same, which shows that the changing of the interval does not change the energy. The frequency remains the same whatever the velocity, and it is for this reason that the densitic frequency is regarded as the differentiating factor.

The Manners and Manneries of Energy. Energy of any particular densitic frequency may be called a Manner (15) of energy, being the manner in which the energial action occurs.

The character of energy, with reference to the peculiar manner or manners of any par-

ticular system of energy, may be called the Mannerism, or Manneric Character, of the energy.

Light includes a certain range of energial manners, and certain ranges of manners evidently produce the greatest effects in the other forms of energy, respectively, and such a manneric range may be called a Mannery (16), and the different forms of energy may be referred to as different energial manneries.

Every system of energy (except, it is supposed, systems of gravity) evidently consists of a number of manners, that is consists of a number of individual, concurrent systems, each of a different manner, which complex character of energy may be called Polymannerism, and the energy may be said to be Polymanneric.

The term Monomanneric may be applied to energy and systems of energy which may be supposed to have but a single manner, as, to gravity, which is probably monomanneric.

Systems of energy, such as the sun's energy,

often include more than one mannery, and such energy may be said to be Polymannerial, and this whether all the manners of each mannery are included or not.

When manners of only one mannery are included in a system of energy, the energy and the system may be said to be Monomannerial.

The Methods of Energy. As explained in the preceding chapter, the internal energy of an atom is supposed to act toward or away from the centre of the atom, which is a method in which the energy acts, and it may be called a Method of energy, being the Centroatomic method of energy, and the matter may be said to be centroatomically energetic.

Considering that the energy acts toward the centre in some atoms and away from the centre in others, if it be supposed that the action is toward the centre in any case, the densits proceeding toward the centre and the positive movement of matter being toward the centre, the atoms may be said to be Proscentrally energetic, and if it be supposed

that the action is away from the centre of the atom, the densits proceeding away from the centre and the positive movement of matter being away from the centre, the atoms may be said to be Apocentrally energetic.

Most of the manners of the solar energy are transmitted through the earth's atmosphere by the same method in which energy is transmitted through the ether, the densits proceeding through the atmosphere just as though it were a body of unparticulate matter, the atmosphere not becoming centro-atomically energetic under such manners, the densits passing through the atoms from side to side.

When the densits which engage an atom pass through it from side to side it may be called the Transatomic method of energy, and the matter may be said to be transatomically energetic.

Since the ether is not particulate in form the term Transatomic is not applicable to the method in which energy is transmitted through the ether. The method in which

energy is transmitted through the ether may be called the Transmissive method, and this term may be used in connection with atomic media also.

For the sake of distinction, the energy which is generated centroatomically in particles or bodies of matter may be referred to as Centroatomic energy, and energy which is transmitted through the atoms or bodies of atomic matter may be referred to as Transatomic energy.

Energy which is transmitted through the ether may be referred to as Transmissive energy, and this term may also be applied to energy transmitted through atomic media.

THE INTENSITY OF ENERGY. Under the theory the intensity of energy depends on the densitic intensity, that is, on the difference in density occurring in consequence of both the positive and negative densits, but as to either quality of energy, considered alone, the intensity depends on the difference between the density of the densits of such quality and the normal density of the matter,

so that in any biqualital system the intensities of the two qualities are equal.

When light is brought to a focus by a lens the densitic intensity increases, because the densitic expanse decreases, and therefore the intensity of the light increases.

DENSITIC CONCORDANCE AND INTERFERENCE. Systems of densits which proceed in the same, or about the same, direction, as in the case of systems which reach the eye from different points in a luminous body, may be referred to as Cogressive systems, and systems which proceed in counter directions, as in the case of systems from two luminous bodies proceeding toward a point between the bodies, may be referred to as Countergressive systems.

When densits of like qualities of two cogressive systems of energy coincide, the positive with positive, and the negative with negative, the densitic intensity is of course increased, and the intensity of the energy is equal to the sum of the intensities of the two systems.

The same is true also when densits of unlike qualities of two countergressive systems of energy coincide, the positive with negative, and the negative with positive.

Such coincidence of densits may be called densitic Concordance, and the resulting increase in intensity may be called densitic Intension.

On the other hand, when densits of unlike qualities of two cogressive systems of energy coincide, the positive with negative, and the negative with positive, the densits of one quality overcome the other, wholly or partially, depending on their relative intensities, and the effect of the energy at the points of coincidence is therefore overcome, wholly or partially, as the case may be.

The same is true also when densits of like qualities of two countergressive systems of energy coincide, the positive with positive, and the negative with negative.

Such coincidence of densits is densitic Interference, which is well established under the undulatory theory, and the resulting

decrease in, or loss of, intensity may be called densitic Vitiation.

Densitic intension and vitiation not only occur in light, but in the other forms of energy also.

During the heating and cooling of iron decalescence and recalescence occur, being due, it is supposed, to densitic vitiation and intension, respectively, owing to increase in the polymannerism of the energy as the temperature rises, and to decrease therein as the temperature drops, the addition of new systems of densits causing interference, and the subsidence of systems lessening the existing interference.

Densitic Consolidation. The visual point, even that with a powerful microscope, includes many atoms, the individual atom being indistinguishable, because, owing to the smallness and closeness together of the atoms, the densits from the contiguous atoms are parallel, as we may say, the systems of densits from the different atoms being consolidated into a single, irresolvable system.

This consolidation of densitic systems from different points into a single system may be called densitic Consolidation.

An area on the sun two hundred miles in diameter is about the smallest extent that can be measured with the aid of a large telescope. A luminous body less than two hundred miles in diameter at the distance of the sun would be seen through the telescope as a mere point of light were it not for internal reflection in the lenses, which would produce an appreciable disk, called the spurious disk by astronomers.

Owing to the great distance, complete densitic consolidation occurs in the light of the fixed stars, which are therefore mere points of light, although they have spurious disks.

The fixed stars are of various colours, red, orange, yellow, green, blue, purple, and white, and here we have strong evidence against the present theory that the different colours are due to different densitic intervals or frequencies, for it is obvious that, owing

to densitic consolidation, the interval and frequency in the light of a star of any colour must be very different from the interval and frequency in the light of a small particle of matter of the same colour.

Under the theory of colour set forth in a subsequent chapter difference in colour does not depend on difference in densitic interval or frequency.

CHAPTER IV

THE THEORY OF ENERGIZEMENT

THE energizement of atomic matter, the incitement of energy in atoms by the energy of other matter, is a new subject.

The principle of energizement is a most important one, for it is through energizement that matter acts on matter; it is through it that all the changes that are ever going on about us are accomplished, and it is through it that all phenomena are produced.

The theory of energizement here advanced is that, all atoms being energetic, the energy of every atom is imparted to the matter in contact with it, whether the ether or other atoms, and the energy of an atom energizes the atoms which it engages in certain ways (methodically, moodically, and modally), de-

pending on the manneric character of the energy and on the energial characters of the atoms engaged.

The Methods of Energizement. Under the theory it is supposed that matter may be energized in any of the following methods:

It may be energized centroatomically by both qualities of all or some of the manners of the engaging energy, which may be called Centroatomic energizement, and the matter may be said to be centroatomically energized.

It may be energized transatomically by both qualities of all or some of the manners of the engaging energy, which may be called Transatomic energizement, and the matter may be said to be transatomically energized.

The matter being composed of different substances, mixed together, one substance may be energized centroatomically by both qualities of some of the manners of the engaging energy, and transatomically by both qualities of the other manners thereof and of the centroatomic energy of the rest of the matter, and the other substance, or each of

the other substances, if more than one, may be energized centroatomically by both qualities of other manners of the engaging energy (each substance, if more than one, being so energized by different manners), and transatomically by both qualities of the other manners thereof and of the centroatomic energy of the rest of the matter, or, one or more of the substances being so energized, the other substance or substances may be energized transatomically by both qualities of all the manners of the engaging energy and of the centroatomic energy of the rest of the matter. This may be called Misceous (mixed) energizement, and the matter may be said to be misceously energized. Translucency results from this method of energizement by light.

The inciting energy being transmissive, matter may be energized centroatomically by one quality of all or some of the manners of the engaging energy, and the same matter may be energized transatomically by the other quality of such manners, which may be

called Kinetic energizement, and the matter may be said to be kinetically energized. It is by this method of energizement that energy actuates particles and bodies of matter to motion.

The matter being molecular, consisting of different kinds of atoms, and one kind being centroatomically energetic, the other kind may be energized transatomically by such centroatomic energy, one quality of such transatomic energy proceeding through the body in one direction, and the other quality proceeding through it in the opposite direction, and other atoms of the kind which are centroatomically energetic and which are engaged by such transatomic energy being energized centroatomically in both qualities of the energy by either quality of the transatomic energy, one quality of the centroatomic energy arising spontaneously. This may be called Polar energizement, and the body may be said to be polarly energized or energetic. It is by this method that polarity is produced in magnets and electrified bodies.

The matter being mixed or particle laden, as a medium containing particles, or there being contiguous, particle-laden bodies of matter, as a wire surrounded by air, and the matter of one kind, as the particles, being centroatomically energized in both qualities of energy, the matter of different kind may be energized transatomically or transmissively in both qualities by such centroatomic energy, and other matter of the kind in which such transmissive energy is generated and which is engaged thereby may in turn be centroatomically energized in both qualities thereby, the centroatomic energy of such matter being transmitted in all directions through the other kind of matter, and so on. This may be called the Electric method of energizement, it being by this method that electricity is supposed to be transmitted. The misceous method may, in some cases, be the same as the electric method.

When matter is energized centroatomically by one quality of energy it is supposed that the other quality of centroatomic energy

arises spontaneously, so that the centroatomic energy incited in the kinetic and polar methods of energizement is supposed to be biqualital.

Under the theory it is supposed that the manners of energy which incite matter to energy, centroatomically or transatomically, spend themselves in such energizement, so that it is not supposed that the same matter can be energized by the same manners both centroatomically and transatomically in both qualities, which would be double energizement; but the double method of energy possibly arises in some cases, to some extent at least, through the kinetic method of energizement. Matter being energized centroatomically in one quality of energy, the other quality arises spontaneously, and being energized transatomically in one quality, the other quality may, to some extent at least, arise spontaneously also.

The Modes of Energizement. The manners of transmitted energy are, evidently, always the same as those of the inciting en-

ergy, but in centroatomic energizement the mannerism or manneric character of the incited energy does not always agree with that of the inciting energy.

In centroatomic energizement the matter may become energetic in the same manners as those which incite it to such energy, or it may become energetic in different manners, and it may become energetic in the same mannery as the inciting energy, or it may become energetic in a different mannery.

The ways in which matter is energized in this respect may be called the Modes of energizement, which, as stated, occur only in connection with centroatomic energizement.

Probably in most cases of centroatomic energizement the matter is incited to the same manners of energy as those which incite it to such energy, as, the manners of the colour energy of objects usually agree with the manners of the light which incite the matter to such colour energy. This may be called the Homomanneric mode of energizement, or homomanneric energizement.

In some cases of centroatomic energizement, as in fluorescence, the matter is energized in other manners than those which incite it to such energy, which may be called the Allomanneric mode of energizement, or allomanneric energizement.

In most cases of centroatomic energizement the matter is energized in the same mannery as the inciting energy, and this may be referred to as the Homomannerial mode of energizement, or homomannerial energizement.

In some cases, however, as in calorescence and in the energizement of black matter by light, the matter is energized in another mannery than that of the inciting energy, and this may be referred to as the Allomannerial mode of energizement, or allomannerial energizement. It is by this mode that the transformation of energy is, under the theory, supposed to be accomplished.

It is evident that some kinds of matter may be energized centroatomically in one

mannery by one quality of energy, and centroatomically in another mannery by the other quality of the same energy, which may be referred to as the Disqualital mode of energizement, or disqualital energizement. Differences in colour are, under the theory, supposed to result from this mode of energizement.

It would seem that some kinds of matter are energizable centroatomically in certain manners when incited by any of the manners of a mannery, and in some cases when incited by manners of other manneries. This may be referred to as the Idiomanneric mode of energizement, or idiomanneric energizement. It is probable that colour-blindness is due to this mode of energizement.

In homomanneric energizement the matter may not be energized homomannerically by all the manners of the engaging energy, as red matter is homomannerically energized only by the red manners, as we may say, of white light, being allomannerially energized by the other manners, which are thereby

eliminated from the colour energy, becoming manners of heat or chemicity.

The Moods of Energizement. Gold is yellow in colour, and the colour energy evidently comes from the superficial atoms, as shown by the fact that if we place two or three gold leaves together and hold them between the eye and the sun no sunlight will reach the eye through them, but if a single gold leaf be held between the eye and the sun some light will reach the eye through it. We may say, therefore, that the energy which gives us vision of a piece of gold comes from the atoms to about the depth of the thickness of a gold leaf.

Paper of considerable thickness may be held between the eye and the sun and some light will reach the eye through it, which shows that the colour energy which gives vision of paper comes from a much greater depth than in the case of gold.

While the depth from which the colour energy of opaque matter comes is different in different substances, it comes from a

limited depth in all kinds, and since such atoms are energized without the other atoms in the body being similarly energized, it may be called a Mood of energizement.

When only a limited portion of a body is energized, or when the body must be small or thin in order to be energized throughout, it may be called the Limited mood of energizement, or limited energizement, and the matter may be said to be limitedly energized.

When a piece of iron is heated at one point it becomes hot throughout. The matter is centroatomically energetic and the energy is communicated from atom to atom so that the atoms in the whole body or in a considerable portion of it become energetic together. This may be called the Comprehensive mood of energizement, or comprehensive energizement, and the matter may be said to be comprehensively energized.

ENERGIZABILITY. The susceptibility of matter to energizement, either centroatomically or transatomically, by the different manners of energy, whereby it is energizable

centroatomically by some manners and not by others, and whereby it is energizable transatomically by some manners and not by others, may be called its Energizability.

ENERGIZATIVITY. The energizative power of energy—that is, the power of energy to energize matter, centroatomically or transatomically, may be called its Energizativity.

The energizativity depends largely on the mannerism of the energy, and since the mannerism of the energy depends on the energitia of the matter in which the energy is generated, it is proper, speaking metonymically at least, to apply the term Energizativity to such matter also.

Some kinds of atomic matter, such as the air, are energizable centroatomically by some of the manners of the engaging energy, and at the same time they are energizable transatomically by the other manners thereof, and when the engaging energy is light, the result is translucency and transparency.

The air transmits most of the manners of the sunlight, being transparent as to them,

and it is energized centroatomically by the other manners thereof, being translucent as to them, and, under the theory, the daylight or skylight is supposed to result from such centroatomic energizement of the air and atmospheric dust particles (see experiment in Chapter XV, showing interference in daylight), and the blueness of the sky is the colour effect of such atmospheric energy, for all light energy has some colour effect (17).

Translucent matter is always transparent to some degree, the transparent quality making it possible for the centroatomic energy to be transmitted from the points in the interior of the body to its surface. The light so generated gives vision in all directions of the matter in which it is generated, both at the surface and in the interior of the body, showing that the densitic form is spherical.

Transparent matter is energized transmissively, while in translucent bodies some of the matter is energized centroatomically, and the energy of such matter is transmitted

transatomically by the other matter, which is transparent, the presence of more than one substance being necessary to translucency. Translucent matter is visible from all directions when light is transmitted through it in a single direction; whereas transparent matter is invisible.

Thin bodies of opaque matter transmit some light, but they are not transparent on that account. The superficial atoms engaged by the light are energized centroatomically thereby, but such centroatomic energy is not transmitted through the other atoms. The atoms energized by the light energize centroatomically the atoms in contact with them, and these in turn energize centroatomically the atoms in contact with them, and so on through the body, the energy of the atoms at the opposite surface being imparted to the air. Such transmission of light may be called Pelluminence. Paper is Pelluminent, and when oiled it is translucent, the oil being transparent.

The centroatomic energizement of matter

in this way may be called Interatomic energizement, in contradistinction to Direct energizement, whereby atoms are energized directly by transmitted energy which engages them.

It is not to be supposed that any particular matter is energizable in the same way by the same manners of energy, under all conditions, for it is obvious that the energizability of matter depends on its energial condition, due to energizement by the energy of surrounding matter of different kinds and in different energial conditions.

Environment is an important factor in energizement.

White matter is energizable in all the manners of light, together, separately or in any combination, a white screen showing any color that may be thrown upon it. White matter may therefore be said to have General energizability in the manners of light. Matter of other colour is energizable in the light manners of its colour only, and such matter may therefore be said to have

Limited energizability in the manners of light. Black matter is Nonenergizable in the manners of light, such matter being energizable in manners of heat by the manners of light.

The Radiation and Absorption of Energy. Energy, being a condition of matter, cannot, like a material thing, be transferred from one body to another; cannot, like a material thing, be absorbed by one body out of another. A condition can only be incited or changed and under the theory this is accomplished through energizement.

Radiation of energy is the incitation of energy in other matter, transmissively or centroatomically, and the incitement of matter to centroatomic energy by the energy of other matter is the absorption of energy, the energy radiated by such matter in turn affecting the other matter, and if it be of a lower order of energy, the energy of the other matter is degraded thereby.

Not only is the less energetic matter affected by the energy of the more energetic matter, but the latter is also affected by the

energy of the former, for, under the theory, every particle and body of matter is affected by the energy of other particles and bodies. This may be called Reciprocal energizement, and it plays an important part in the radiation and absorption of energy, giving rise to the Theory of Exchanges (18).

When cold water is mixed with hot water the mixture takes an average temperature, the equalization of temperature being accomplished through reciprocal energizement, and if the average temperature of the mixture is abnormal, either above or below the temperature prevailing at the place at the time, the temperature of the mixture gradually changes until it is normal, such change being brought about through energizement by the energy of the surrounding matter, the air, the ground, and the objects thereabout. Reciprocal energizement occurs in such a case, and that prolongs the process of equalization.

The atmosphere of a planet is energized centroatomically and comprehensively by

some of the manners of the sunlight, depending on the elements of which the atmosphere is composed, and such energy is radiated, being the light by which the planet is seen. When there is no atmosphere, as in the cases of Mercury and the moon, the solid matter is energized centroatomically and limitedly by some of the manners of the sunlight, and such energy is also radiated, being the principal light by which such bodies are seen (19).

A body with an atmosphere radiates much more light than one without an atmosphere, their sizes being the same, because more matter participates in the radiation, and the denser the atmosphere, and the greater the number of elements composing the same, the greater the radiation, because the greater is the number of manners of the sunlight energizing the same.

The albedo of Mercury is 13; that of the moon is 17; that of Mars, with his rare atmosphere, probably containing but few elements, is 26; and that of Jupiter, with his dense atmosphere, probably containing many

elements, is 75. The numbers represent the ratios of radiation.

THE ENERGIAL IMPRESSIBILITY OF MATTER. There is much evidence to support the idea of the energial impressibility of matter; indeed, if there were no other examples, our own susceptibility to physical and mental training would be sufficient.

By energial impressibility is meant the susceptibility of matter to being impressed, as we may say, so as to become energetic more readily in some particular way, mannerically, methodically, moodically or modally, on account of having previously been so energetic, or it is the susceptibility to being impressed so as to continue in action in some particular way which has been impressed upon it.

As an example of the first kind: When a vulcanite comb is rubbed at one end for a short time it does not develop the power of attraction throughout, but if so rubbed for a long time it does develop the power throughout, and if the energetic condition be then

allowed to subside, when it is again rubbed as before the power of attraction is readily developed throughout the comb.

As an example of the latter kind: The energy in a magnet which gives rise to polarity acts in a certain way, established at the time of magnetization, and the matter continues so to act as long as it is such magnet, the poles being maintained at their respective ends.

The condition which is thus impressed on matter, and the state of being so impressed, may be called Impressure, and the matter may be said to act in such way through, or on account of, impressure, and may be said to be in a state of impressure.

Impressure is energitial modification of a lasting nature.

Different kinds of matter have different energial impressibilities. One kind may be impressible to some particular way of action, while another kind may not be to the same way of action, but may be to some other way.

CHAPTER V

THE THEORY OF THE SPECTRAL LINES

THE Fraunhofer lines of the spectrum do not represent the utter extinction of parts of the light, but they merely represent a decrease in the intensity of some of the manners of the light, and the reason for such decrease is readily understood under the theory of energizement.

The velocity of light is not only different in different media, giving rise to refraction, but the velocities of the different manners are different in the same medium, so that the ratios of velocities of the different manners in any two media are different, the dispersion of the colours through refraction being due to this fact.

The subject of colour will be considered in

a subsequent chapter. Here it will be sufficient to say, that, under the theory, it is supposed that the different manners represent different hues, so that when the different manners of light are separated in the spectrum of high dispersion, decrease in the intensity of any of the manners becomes apparent.

Under the theory it is supposed that when light passes through a gas or vapour, the gas or vapour is energized centroatomically by some of the manners of the light, depending on the energizability of the matter, different substances being energizable by different manners, a substance being especially energizable, centroatomically, by the manners which agree with the manners of its own energy when augmented, all other manners being transmitted transatomically, being the misceous method of energizement.

The manners of light which energize the gaseous matter centroatomically spend themselves in such energizement, being thereby eliminated from the transmitted light, and

their places in the transmitted light are taken by the manners of the centroatomic energy, and when the energizement is homomanneric the manners agree with the eliminated manners, except in intensity, the intensity of the incited centroatomic energy being less than that of the inciting energy, just as the intensity of the colour energy of an object is less than that of the light which incites the matter to such energy. When the energizement is allomanneric the manners of the centroatomic energy do not agree with the eliminated manners, and in such cases they do not take the places of the eliminated manners in the spectrum, but occupy other places therein, leaving dark spaces which have no significance, probably interfering with the spectra of other substances and causing confusion in the spectral lines (20).

The light beyond the gas includes some of the original light and also the light generated by the gas under such energizement, and the two being of different intensities, the portions of the spectrum formed by the latter are

much darker than those formed by the former, and these darker portions are the Fraunhofer lines, which, as before said, are not due to an entire absence of light from those portions of the spectrum where they appear, such portions being dark merely by contrast with the brighter portions (21).

During a total eclipse of the sun the bright portions of the solar spectrum become black, and the dark portions become bright. When totality occurs the change can be clearly seen, the dark lines flashing out brightly when the bright lines become black.

The body of the sun, the photosphere, which is the origin of the sunlight, is surrounded by a gaseous envelope, the chromosphere, and all the light from the photosphere must engage the chromosphere. Some of the manners of the light are transmitted transatomically through the chromosphere, while others energize the chromospheric matter centroatomically.

The chromospheric energy is light energy of a lower luminosity than that which is

transmitted directly, and it is propagated out into space along with the rest of the light.

That the light in the dark lines is the centroatomic energy of the chromospheric matter is shown by the fact that during a total eclipse of the sun only the portion of the chromosphere which is at the sun's limb can be seen, and it is the light from that portion which forms the chromospheric spectrum during the eclipse.

The light from the photosphere which passes through that portion of the chromosphere has a direction about at right angles to the line between the sun and the earth, so that the light coming to the earth from that portion of the chromosphere must proceed about at right angles to the direction of the light from the photosphere which energizes that portion of the chromosphere, showing that the densitic form of the chromospheric light is spherical, which would be the densitic form of the centroatomic energy of the energized gas.

The solar spectrum does not indicate the presence in the sun of all the elements of which we know, or at least the spectra of all the elements of which we know cannot be identified in the solar spectrum.

Taking into consideration the fact that the matter of which the sun and planets are composed was at one time a nebulous mass, in which the different substances were most likely mixed and scattered throughout the mass, it is supposable that all the elements should exist in the sun, and it is also supposable that the chromosphere should contain gases of all such elements, but of course it may not, or at least not to such an extent as to make their presence apparent through the spectrum.

But however this may be, under the theory of energizement it is easy to understand how, in such an environment, subject to the energies of many other substances, a substance may have its energitia so modified as to produce an unrecognizable spectrum (22).

CHAPTER VI

THE THEORY OF ENERGIAL MOTION

WE are confronted on every hand with moving matter; we see one particle or body of matter move this way or that under the influence of other particles or bodies without any material attachment between them, and we see the particles in an aggregation of highly energetic particles, such as in a heated liquid, in great commotion, flying hither and thither and away, and when restrained, exerting great force in an effort to escape.

That energy is the cause of such motion is certain, but no explanation has been offered of the manner in which matter is actuated to motion by energy, and the theory of energial motion (23) is advanced in explanation thereof.

It may be truly said that the movement of matter by its own energy, incited of course by the energy of other matter, underlies all the principal phenomena of the world. It underlies the formation of molecules and the formation of bodies and worlds; to it are due the axial rotation of the astral bodies, the motion of bodies under gravity, and the attraction and repulsion of matter by the magnet, and to it are due the motions of particles in chemical reaction, combustion, explosion, evaporation, and atomic dissemination.

As explained in a preceding chapter, energy being biqualital, it is supposed, under the theory of energizement, that matter may be energized centroatomically by one quality (either quality), and transatomically by the other, this being the kinetic method of energizement, and under the theory it is supposed that the transatomic energy so incited causes the matter to move.

Of course an atom cannot be actuated to motion by centroatomic energy, whether the

energy be biqualital or not, because the actions on the opposite sides of the centre are equal and in opposite directions, whether apocentral or proscentral, and when both qualities of transatomic energy are present the actions are equal and in opposite directions, so that matter cannot be actuated to motion by biqualital transatomic energy, but if one quality of the transatomic energy be eliminated, then, since all the matter in the atom moves in one direction only, the atom must of course move in that direction.

We see, therefore, that kinetic energy (24) must be transatomic and uniqualital.

Owing to the surrounded condition of particles and bodies of matter, we may say, speaking, generally, that energial motion results from a preponderance of action in the direction of motion in any case, or that it is the result of actions in diverse directions, the motion being in the line of the resultant, rather than that the action is only in the direction in which the motion is, although in some cases this may be about true.

In a solid body the atoms occupy fixed positions as to each other, but for the purpose of explanation we may consider that the atoms composing a body might be close together, but not actually touching, each being free. It is clear that if all such free atoms move in one direction, the whole aggregation of atoms would move in that direction, and if the atoms all move at the same speed, they would maintain their relative positions, and the form of the aggregation would not suffer any change. If, while the atoms were so moving together in the same direction and at the same speed, maintaining their relative positions, cohesion should take place between them, the motion of the aggregation would not be interfered with.

We see, therefore, that if the kinetic energy in all the atoms of a body preponderate in any direction, the body will move in that direction, and we may take it as a fact that in energial motion the motion of the particles composing a moving body is taken up in the

motion of the body, the particles remaining stationary as to each other.

Now, since there are two qualities of energy, under the theory it is supposed that the transatomic energy arising in matter under kinetic energizement may be of either quality, positive or negative, and since the movements of matter are in opposite directions in the two qualities, the motions in the two cases will of course be in opposite directions.

If the transatomic energy be positive, the motion will be away from the point of generation of the inciting energy, and if it be negative, the motion will be toward the point of generation of the inciting energy. Repulsion will occur in the one case, and attraction in the other.

When repulsion occurs we may say that the kinetic energy is Repulsive in its action, and that the matter is repulsively energized, and when attraction occurs we may say that the kinetic energy is Attractive in its action, and that the matter is attractively energized.

Since different substances have different

energizabilities, and since energy differs mannerically, the different forms of energy being due to manneric differences, by the theory we are enabled to understand why the different forms of energy produce different effects, attractive and repulsive, and why the same form of energy produces different effects, attractive and repulsive, in different substances or in the same substance under different conditions, and we are also enabled to understand why kinetic energy varies in strength in different substances, and why it varies in strength in the same substance as the manneric character of the energy varies.

It is commonly supposed that all atomic matter is always energized attractively by gravity, and the paramagnetic substances are energized attractively by magnetism, while the diamagnetic substances are energized repulsively thereby. Depending on the conditions, atomic matter is sometimes energized repulsively by heat and chemicity, and at other times it is energized attractively thereby.

Now, it is obvious that if the densits of the kinetic energv are far apart, only part of the matter in the engaged body will move at a time, and that might not be sufficient to give motion to the body, or, if so, the motion would be slight, because there would be opportunity for the matter to move back in the opposite direction, the opposite densition arising spontaneously if not prevented by quickly succeeding movements. If, however, the densits are close together so much of the matter in the body will move at the same time that there is but little opportunity for the matter at any point to move back, so that such movement of matter gives motion to the body.

In most cases of energial motion there is probably some backward movement of matter, not sufficient to entirely counteract the primary movement, but enough to lessen the bodily motion.

Densitic congestion, as closeness together of the densits may be called, is, therefore, conducive to energial motion.

Systems of different manners generated at the same point, and systems generated at different points in a body and proceeding in the same general direction, so that portions of them engage a body of matter at the same time, are Concurrent systems of densits.

The greater the number of concurrent systems, the greater the densitic congestion, and the greater the effectiveness of the kinetic energy.

Polymannerism is especially important in connection with energial motion, because the greater the polymannerism, the greater the probability that the matter will be energized kinetically by many of the manners, and the greater the number of manners in the kinetic energy, the greater its effectiveness.

Augmented energy is highly polymanneric, and the higher the augmentation, the greater the polymannerism of the energy, and we therefore see why energial motion is common among particles having augmented energy.

In a body of highly energetic matter, such as a piece of highly heated iron, there is un-

doubtedly considerable reciprocal energizement between the atoms in the kinetic method, and, obviously, in such a case there is a preponderance of kinetic energy in all directions away from the centre of the body, and under the theory it is supposed that this, not being sufficient to overcome the cohesion between the atoms, causes a slight distension of the atoms, which distension results in the expansion of the body.

When objects or particles are energized kinetically and they are restrained from moving, they have a forcible tendency to move. This forcible tendency to move under the action of gravity is manifested as weight. Between the particles of a gas or vapour which are confined so that they cannot fly apart, the repulsion is manifested as pressure.

Under the theory it is supposed that, though the different kinds of atoms have different densities, the differences in weight of the different substances are not entirely due to differences in their densities, but that,

owing to the differences in density, solidity, and elasticity, and to the consequent differences in their energitias (see note 14) and energizabilities, the effectiveness of gravitial energizement is different in the different elements. Under this conception mass is more a measure of force than a measure of matter.

CHAPTER VII

THE THEORY OF CHEMICAL REACTION

ATOMS possess the remarkable property of combining with atoms of other kinds in certain numerical ratios, forming molecules, and the molecules so formed possess properties very different from those of the constituent atoms when not so combined, the atoms of a molecule losing their individual characters when they become associated together in the molecule.

Molecular formation, molecular change through the addition, elimination, or substitution of atoms, and molecular dissociation are the processes by which remarkable changes in atomic matter are accomplished.

These processes are commonly referred to as chemical processes, and the mutual ac-

tions of the atoms by which these things are accomplished are commonly referred to as chemical reaction.

Under the theory of energizement it is supposed that chemical reaction is due to the reciprocal energizement of the atoms.

We have applied the name Chemicity to energy which causes chemical reaction (see note 13), being the natural energy of aggregate atomic matter, and including heat and light.

Different manners of chemicity produce different chemical effects, and the same manners may produce different effects in different substances.

Under the theory it is supposed that the atoms are actuated together into the molecule through reciprocal energizement in the kinetic method, the atoms being attractively energized, and it is supposed that the disruption of molecules and the elimination of atoms from molecules are accomplished through reciprocal energizement in the kinetic method, the atoms being repulsively energized.

It is supposed that the energitias of the atoms of a molecule are modified through reciprocal, centroatomic energizement, so that their energizativities and energizabilities are different, and they have not the distinctive characteristics which they have as free atoms.

It is supposed that each kind of molecule has a distinctive energitia, or energial character, the combined modified energies of the constituent atoms being the energy of the molecule, the atoms continuing to be individually energetic, for otherwise they could not be separated, the separation of atoms out of molecules being accomplished by energial actuation through energizement.

Of course all the manners of energy by which all the atoms of the molecule are, under the conditions, energizable transatomically, affect the molecule as a whole, so that, when kinetically energized thereby, the molecule moves as a whole.

Different kinds of atoms have different degrees of chemical affinity for each other,

and the chemical affinity between the same kinds of atoms may be different under different conditions, and under some conditions atoms which have chemical affinity for each other under other conditions may be chemically repugnant to each other.

These differences are, under the theory, due to the different energitias of the different kinds of atoms, and to modifications in their energizativities and energizabilities through energizement by other kinds of atoms which are present, the environment having much to do with the energizement of matter.

In the formation of molecules atoms combine in certain numerical ratios, and this is ascribable to the modifications which occur in the energies and energizabilities of the combined atoms.

As soon as certain numbers of atoms of the different kinds combine, their energies become so modified, through modification of their energitias by reciprocal energizement, that the free atoms of the same kinds which are present are not energizable attractively by

the energy of the combined atoms, and the energizabilities of the combined atoms become so modified, through reciprocal energizement, that they are no longer energizable attractively by the energy of the free atoms, so that, under the conditions, there is no such reciprocal energizement between the combined atoms and the free atoms as would bring them into combination.

In molecular formation certain conditions are often necessary to bring about the combination, as in the formation of the water molecule a very high temperature is necessary.

Under different conditions different molecules may often be formed from the same kinds of atoms as form other kinds of molecules under other conditions, as under different conditions from those under which the water molecule is formed two atoms of oxygen and two of hydrogen combine, forming a molecule of peroxide of hydrogen.

The energial conditions of the atoms necessary for the formation of molecules may often

be produced by the energy of a catalyzer, which, without being affected itself, effects the combination, as, platinum causes hydrogen and oxygen to combine and form the water molecule.

There are also negative catalyzers, which bring about the dissolution of molecules or cause the dissociation of some of the atoms, as, gold causes the dissociation of one of the atoms of oxygen from the molecule of peroxide of hydrogen.

Combustion and explosion are caused by the remarkable dissociating power of oxygen at high temperatures. The energitias of the atoms of the molecules are modified through energizement by the energy of the oxygen, and, through reciprocal energizement, the atoms of the molecule energize each other repulsively, instead of attractively, and they repel each other, disrupting the molecule and flying asunder, and the oxygen thereupon combines with some of the released atoms. In explosion tl.e repulsion is very forcible and violent.

CHAPTER VIII

THE THEORY OF GRAVITY

EVERY particle of matter in the universe attracts every other particle with a force that is directly proportional to the masses of the attracting particles, and inversely proportional to the squares of the distances between them.

This is the Law of Gravitation, established by Sir Isaac Newton in his *Philosophiæ Naturalis Principia Mathematica.*

While the law of its action has long been understood, the nature of gravity, and the way in which it acts on matter, the method by which it actuates matter to motion, have remained unexplained. A number of theories have been advanced, but none has been accepted (25).

Some look upon gravitation as a mysterious effect without any explicable cause (26), but most physicists consider it to be the effect of energy, which is the sensible view.

Under the theory here advanced it is supposed that gravity is a form of energy, essentially the same as the other forms of energy, differing from them only mannerically, it being supposed that the densitic interval is the shortest, and the densitic frequency the highest, of all the forms of energy, and gravity is supposed to be monomanneric.

In a large body of matter there must of course be a great deal of densitic consolidation in gravity, which of course increases the densitic intensity, and which, most likely, makes it possible for gravity to act over such great distances.

Such consolidation affects the intensity only, and does not make the energy polymanneric, but it is probable that on account of such consolidation, since it is not likely that all the densits of any single direction would coincide, there are densitic combina-

tions of different intensities in the gravitial system of a large body.

It is supposed that every atom is inherently and perpetually energetic in this form of energy, which is looked upon as the primordial energy, for it is conceivable how its action in bodies of atomic matter might, through reciprocal energizement, give rise to other forms of energy, or to some other manner or manners, from the action of which other manners arise, and so on.

The occurrence of gravity in all matter and its incessant action indicate that it is the primary form of energy, and if through reciprocal gravitial energizement other manners of energy arise, it would be the primary form.

All other forms of energy occur in aggregations of atoms or in bodies of atomic matter in consequence, evidently, of interatomic energizement, but gravity is inherent in each and every atom, occurring in each atom regardless of the others.

The other forms of energy are changeable,

the changes being caused by changes in the relation of the atoms of a body, or in the relation of different kinds of atoms, or in the relation of different bodies as to each other, which clearly shows that those forms of energy are due to interatomic action. Such relational changes of atoms and bodies do not produce any change in gravity, which shows that gravity is inherent in each and every atom, and that it is independent of interatomic action.

It is supposed that gravity is generated as centroatomic energy, all atoms probably being proscentrally energetic in this form of energy, and that it is densitic in nature, and biqualital, consisting of both positive and negative densits, the densits being spherical in form, so that the energy of each atom acts in all directions from it.

It must be supposed that bodies at a distance from each other are actuated toward each other by some action set up in each of them by some action in the intervening medium, each body producing the action in

the medium which causes the action in the other body.

We must therefore take it, since gravity is incessant in its action, that all atoms are incessantly energetic in the form of energy which is gravity; that the energy of each atom is being continually imparted to the surrounding matter and transmitted away through it, and that other atoms engaged by the transmitted energy are incited to such a method of action as causes them to move toward the atom from which the inciting energy comes.

Gravity being biqualital, under the theory it is supposed that both qualities are transmissible through the ether, but that only the negative quality is transmissible through atomic matter, the positive quality energizing the matter centroatomically. In other words, all atomic matter is energized by gravity attractively in the kinetic method (27).

Gravity, like the other forms of energy, varies in intensity inversely as the squares

of the distances over which it is transmitted, and if it is true, as commonly supposed, that gravity suffers no deterioration in transmission through bodies of atomic matter, other than the natural decrease in intensity due to the increase in densitic expanse with distance, it must be that the matter acts naturally to it without resistance.

Gravity evidently has the same velocity in all matter, for otherwise there would be refraction in passing at an angle from one kind of matter to another.

What the velocity of gravity is cannot be said. It is thought that its velocity must be millions of times greater than that of light; that its transmission between the sun and the earth must be instantaneous, for otherwise, it is said, the effect of the time of transmission between the sun and the earth would cause a noticeable variation in the earth's period of revolution.

The solar gravity is being continually transmitted away from the sun in all directions, and the earth and other planets are

always in the field of solar gravity, notwithstanding their motions.

If the sun and the earth were both stationary in space of course gravity would always act in a line between the centres of the two bodies.

The earth travels in its orbit around the sun more than a million and a half miles a day, and it takes light about eight minutes to reach the earth from the sun, so that if gravity has the same velocity as light, the terrestrial gravity acts on the sun from a point about nine thousand miles behind the centre of the earth, but this would not have any effect on the earth, and any effect which it might have on the sun would be indeterminable.

It is commonly supposed that the solar system is moving through space with a speed of about sixteen miles a second, and if this is true, with a gravitial velocity equal to that of light, the solar gravity acts on the earth from a point about 7500 miles behind the centre of the sun, and owing to the eccen-

tricity of the earth's orbit the centre of solar gravitation is not fixed as to the centre of the sun, but it varies very slightly during each revolution of the earth.

This simply means that the centre of the sun is not the centre of gravitation as to the earth, and the earth's revolution is as to such centre of gravitation, and not as to the centre of the sun, and since we are not able to determine the distance between the sun and the earth exactly by many thousands of miles, we are not able to determine exactly where the centre of gravitation is as to the earth.

The fact that the centre of solar gravitation does not coincide with the centre of the sun can make no difference in the period of revolution of the earth, and any variation in the position of the centre of solar gravitation occurs the same during every revolution of the earth, so that if it have any effect on the period of revolution, the same effect occurs during every revolution, and so it is not detectable, for the period of revolution is not variable.

Owing to the great eccentricity of Mercury's orbit, it may be that the secular perturbation in its perihelion is due to the time element in the transmission of gravity, for the centre of solar gravitation as to Mercury changes to such an extent during each revolution that a noticeable variation in the form of the planet's orbit may be produced.

The period of revolution of the planet is not affected, but the perihelion of the orbit moves forward faster than it should under the law of gravitation, which fact has led some astronomers to doubt the exactitude of the law of gravitation.

Under the theory it is immaterial whether mass is the same as quantity of matter or not. Gravity produces a certain effect in each different substance, and the mass of the substance is determined from that effect. If that effect depends on the quantity of matter alone, then mass is the same as quantity of matter, but if the effect depends to any extent on anything else, as on the solidity

and elasticity of the atoms, then mass is not the same as quantity of matter.

It is a matter that cannot be determined. The theory conforms to the law of gravitation in all respects in any event.

CHAPTER IX

THE THEORY OF MAGNETISM

UNDER this theory magnetism is supposed to be energy, and since, as has been said, all energy is supposed to be essentially the same, no radical distinction can be made between magnetism and any other energy which causes attraction or repulsion, but since magnetism has always been considered in connection with the magnet, we shall confine our considerations here to the energy which is generated in the magnet.

The energy is supposed to be generated centroatomically in the iron, being the natural energy of the iron, modified by the energy of the substance with which the iron is combined in molecules, and augmented through a certain method of reciprocal energizement.

Magnetism is supposed to be biqualital and polymanneric, and both qualities of all the manners are supposed to be transmissible through the ether, and, since magnetism acts directly through all atomic substances which are not ordinarily affected by the magnet, it is supposed that the manners of magnetism are transmissible, transatomically, through such substances, so that magnetizable bodies beyond bodies of such matter are affected directly by the energy from the magnet.

It is supposed that when matter is magnetized it is energized centroatomically, and if the energizement be in the comprehensive mood, as it is in magnetic iron and steel, the centroatomic energy is imparted to the medium beyond, and so takes the place of the energy from the magnet spent in such energizement, and in this way other magnetizable bodies beyond such bodies are affected indirectly by the magnetic energy.

It is said that all atomic substances are affected in the strong magnetic field, being

either attracted or repelled, paramagnetic substances being attracted, and diamagnetic substances being repelled.

Iron, nickel, cobalt, titanium, manganese, and chromium are the principal paramagnetic substances, and bismuth and silver are usually referred to as the two most strongly diamagnetic substances.

Attention is called to this remarkable fact: Iron has more lines in its spectrum than any other substance, over two thousand. Next to iron in this respect comes nickel; next comes titanium; next comes manganese; next comes chromium, and next comes cobalt, with over two hundred.

This must be taken as being more than a bare coincidence, and it is in accordance with the theory of energial motion, as explained in Chapter VI.

The energy of iron evidently has greater polymannerism than that of any other substance, and under the theory it is supposed that magnetism is highly polymanneric; hence its great effectiveness as kinetic energy.

Under the theory it is supposed that the energy of a magnet, being biqualital, energizes matter in the kinetic method, energizing paramagnetic substances attractively, and energizing diamagnetic substances repulsively, different substances being so energized by different numbers of manners, steel probably being so energized by all the manners, while other substances are so energized by very few manners, the kinetic effect depending on the number of systems in the kinetic energy.

Under the theory it is supposed that a magnet is energetic centroatomically in both qualities of energy, the iron atoms of the molecules especially being so energetic, and it is supposed that the centroatomic energy of the iron is transmitted transatomically in a certain direction through the magnet by the other atoms of the molecules, which transatomic energy in turn energizes the iron atoms centroatomically, being the polar method of energizement.

It is supposed that the transatomic energy

gives rise to polarity, it being supposed that the positive densition acts in a single direction, toward the positive end of the magnet, and that the negative densition acts in a single direction, toward the negative end of the magnet. The experiments on which this supposition is based are described in the next chapter.

The transatomic energy and densition in a magnet may be referred to as the Polar energy and densition, that which acts toward the positive pole being Positive polar energy and densition, and that which acts toward the negative pole being Negative polar energy and densition.

Since the positive polar densition acts from all points in the magnet to one end of the magnet, there is a densitic cumulation at that end, and, all the positive movements being toward that end, that end is the positive pole, and the opposite end, toward which the negative densition acts (the same acting to the points of generation, so that it all does not act to the end), is the negative pole.

It is remarkable that polarity can become established only in a compound of iron, some other substance, such as oxygen or carbon, being combined with the iron, and, such being the case, it is supposed that in the polar method of energizement one kind of atom is energized centroatomically, and the other kind transatomically.

In the magnet the direction of the polar energy, and the directions of the qualities thereof, are established at the time of magnetization, the direction of the densition being determined by some peculiarity of the body of matter, physical, structural, or dimensional, the peculiar arrangement of the different atoms of the molecules as to direction, different elasticities in different directions, or different dimensions in different directions, or being determined by the way in which the magnetizing energy is applied during magnetization.

It is clear that the directions of the qualities of the polar energy are etablished in the last-mentioned way.

Once established, the polar densition continues to act in the established directions under methodic impressure.

Under the theory the centroatomic energy is the energy which effects the attraction and repulsion of matter, the polar energy maintaining, through energizement, the high state of energy in the iron atoms and affecting the energitia of the matter, making the energizability of the matter at one end of the magnet different from that of the matter at the other end, and making the centroatomic energy generated at one end of the magnet mannerically different from that generated at the other end.

Except in the case of one magnet acting on another magnet, the effects produced by the magnetism from one end of a magnet are sensibly the same as those produced by the magnetism from the other end—that is, paramagnetic substances are energized attractively by the magnetism from either end, and diamagnetic substances are energized repulsively by the magnetism from

either end, which shows that the energy from each end is biqualital.

In the case of two magnets acting on each other, like poles repel, and unlike poles attract, and it is in this respect that polarity manifests itself.

It is reasonable to suppose that the mannerism of the centroatomic energy of a magnet is affected by the polar energy, and owing to the said difference in the polar densition at the opposite ends of the magnet, it is reasonable to suppose that the mannerism of the centroatomic energy generated at the positive end of a magnet is different from that of the centroatomic energy generated at the negative end, and for the same reason it is also reasonable to suppose that the energizability of the matter at the positive end of a magnet is not the same as that of the matter at the negative end.

Under the theory, therefore, it is supposed that the energizability of the matter at either end of a magnet is such that it is energizable attractively, in the kinetic method, by the en-

ergy from the unlike pole of another magnet, and is energizable repulsively by the energy from the like pole of another magnet.

Induction. When a magnet attracts a piece of steel, not only does the steel move toward the magnet, but the magnet, if free to move, moves toward the steel also.

The explanation is this: The steel, being energized in the kinetic method by the energy from the magnet, is energized centroatomically in both qualities of energy by one of the qualities of the energy from the magnet, the other quality of centroatomic energy arising spontaneously as a consequence of the one, which, it is supposed, always occurs in such method of energizement. The centroatomic energy of the steel is imparted to the medium and transmitted to the magnet, and, being magnetic energy, it energizes the magnet in the kinetic method, attractively.

This is reciprocal induction, and it is by this process that the energetic condition of the magnet is maintained, being the process by which the keeper, the piece placed on a

magnet when not in use, keeps the magnet from deteriorating.

LINES OF MAGNETIC FORCE. When a magnet is held underneath a piece of paper on which there are steel filings, the filings arrange themselves in lines radiating outward from the ends of the magnet and curving outward between the two ends. The lines thus represented by the filings are called lines of magnetic force.

Draw a line two inches long and let it represent a slender magnet, and with compasses describe a series of concentric circles (forty-eight in number, say) around each end as a centre, beginning at each end with a radius of a sixteenth of an inch, the circles of each series to be a sixteenth of an inch apart.

The circles of the two series will intersect at points opposite the sides of the magnet and also beyond the ends of the magnet.

Let the circles represent positive densits proceeding away from the ends of the magnet. The negative densits would be represented by intermediate circles.

Beyond the ends of the magnet the densitional movements in like qualities of densits in the two systems have the same general direction. In the line of the magnet they have the same direction, but at points away from such line their directions are somewhat diverse.

At points of densitic intersection where the movements are in diverse directions the matter cannot move in both systems simultaneously in such diverse directions. It will move in a single intermediate direction, depending on the relative strengths of the two systems at the points of intersection, and such line of movement may be called the Line of the energial Resultant.

One end being attracted and the other repelled, each steel filing turns so that its long dimension lies in the line of the resultant at the point where the filing is, and, owing to the greater intensity of the energy from the nearer end of the magnet, these lines are about radial from the nearer end.

Densitic intension or vitiation, as the case

may be, occurs at the points of densitic intersection, and lines drawn through the points of densitic intersection from the ends of the magnet will represent lines of intension or vitiation, as the case may be, taking into account the qualities and the cogressiveness or countergressiveness of the two systems.

The steel filings arrange themselves in lines agreeing with the lines of densitic intension.

Opposite the sides of the magnet-like qualities of the two systems of energy act more or less in opposition, acting in direct opposition at the sides of the magnet, and by taking into account the relative strengths of the two systems, the line of the resultant at any point of intersection may be determined.

Opposite the middle of the magnet, in the line of the magnet's equator, the two systems are of equal strengths, and the lines of the resultants are parallel with the magnet. Between the equatorial line and either end of the magnet the lines of the resultants are angling, being directed more and more toward

the ends of the magnet as the ends are approached.

Such being the case, the lines of the resultants at the various points of densitic intersection opposite the sides of the magnet have directions which may be indicated by curved lines drawn from end to end of the magnet through the points of densitic intersection, and such lines agree with the lines of force opposite the sides of a magnet, as represented by the steel filings.

Change in Length of Magnetized Bar. When a bar of steel is magnetized it increases in length until saturation is reached, after which it decreases in length. When a bar of cobalt is magnetized it at first decreases in length, and then increases in length. When a bar of nickel is magnetized it decreases in length only.

Under the theory it is supposed that the changes in length are produced by the polar densition, for, such densition consisting of many systems of each quality, it is conceivable that the systems of opposite qualities,

the movements of matter being in opposite directions, might be so related to each other at one time or in one case as to cause extension of the bar, and might be so related at another time or in another case as to cause contraction of the bar.

In a single densitic system a negative movement is away from the preceding positive movement and toward the following positive movement, so that in a single system the movements toward one another are equal to the movements away from one another, and on the whole there is neither extension nor contraction.

The energy is polymanneric, and there are many densitic systems of different intervals, and owing to the different intervals the relation between the opposite movements of the polar systems might be such that the movements toward one another would preponderate over the movements away from one another, which would cause contraction of the bar, and, on the other hand, the relation might be such that the movements

away from one another would preponderate over those toward one another, which would cause extension of the bar.

INTERMEDIATE POLES. In a magnet several feet in length there are intermediate poles, just as if the bar were divided into several pieces, each with a positive and a negative pole.

The explanation evidently is that there are places of general densitic interference between the polar systems of different densitic intervals, the energy being polymanneric. There is undoubtedly some densitic interference all along a magnet, but only at certain places is there general interference.

Such places of general interference are places of densitic vitiation, dead places, as it were, and the section of the bar between such a place and the end of the bar, or between two such places, has polarity within itself, because at one end thereof there is greater cumulation of positive densits than at the other, and at the opposite end there is greater cumulation of negative densits than at the other.

CHAPTER X

THE THEORY OF ELECTRICITY

TEXT books on electricity begin with the statement that if certain substances, as amber, sealing wax, and glass, are rubbed with certain other substances, as flannel, silk, and fur, they attract bits of paper and pith balls, and it is said that such bodies, both those that are rubbed and those with which the rubbing is done, are electrified, one positively and the other negatively. It is said that vitreous bodies are usually electrified positively, and that resinous bodies are usually electrified negatively, depending in either case, however, on the substance with which the rubbing is done, as, when glass is rubbed with silk it is said to be positively electrified, and when it is

rubbed with fur it is said to be negatively electrified.

Many substances develop the power of attraction through friction, some more strongly than others, and many substances, as wood, cork, bone, celluloid, and metal, do not develop the power, and the attractive power is developed more strongly by rubbing with some substances than with others, as sealing wax probably develops the power most strongly when rubbed with flannel, a stick of sealing wax, rubbed with flannel for half a minute, attracting a strip of paper hanging from the edge of a table over a distance of eight inches.

The power of attraction is developed in sealing wax, vulcanite, and glass, as well as in some other substances, when the rubbing is done with any one of many things: wool, silk, cotton, fur, paper, chamois, leather, rubber, wood, cork, bone, celluloid, metal, vulcanite, sealing wax, paraffine, beeswax, a clothes brush, the palm of the hand, and other things.

All substances which develop the power attract paper, and so paper may be used for testing, a strip of newspaper eight inches long and a sixteenth of an inch wide, hanging from the edge of a table, being the most convenient.

Thread an ordinary steel sewing needle and let it hang from the edge of the table by the thread. With a drop of sealing wax fasten a piece of thread to the edge of a copper cent, and in the same way fasten other threads to a nickel, a silver dime, a five-dollar gold piece, and to small disks of lead, zinc, and aluminum, and to a cork, and hang these from the edge of the table. Loop doubled pieces of thread around the middles of an oblong rubber eraser, a stick of sealing wax, a wooden rod of the dimensions of a lead pencil, a glass rod of the same size, a paraffine candle, and a draftsman's celluloid triangle, and hang these in a balanced condition from the edge of the table.

It will be found that a stick of commercial sealing wax will attract all these things, caus-

ing them to turn, when rubbed on any of the things mentioned, but when rubbed on some things, as castile soap, it will not attract any of them, paraffine being the only substance, as far as determined, which develops the power of attraction when rubbed on soap.

A glass sphere and a vulcanite comb attract these things also when rubbed on any of the things mentioned.

Paraffine develops the power of attraction when rubbed on any of many things, but when rubbed on paraffine, both pieces being first dipped in water, or when rubbed on beeswax, it does not.

Beeswax develops the power of attraction when rubbed on any of many things. When paraffine and beeswax are rubbed together neither develops the power appreciably. Paraffine develops the power when rubbed on soap and also when rubbed on wood, but beeswax does not develop it when rubbed on either.

When some substances are rubbed together only one of them develops the power

of attraction, as paraffine on soap, and when metal, wood, cork, celluloid, or bone is one of the substances it does not develop the power.

In some cases when two bodies of the same substance are rubbed together both develop the power of attraction, as vulcanite on vulcanite and sealing wax on sealing wax, but in other cases neither of the bodies develops the power, as paraffine on paraffine, beeswax on beeswax, and glass on glass.

A rubbed body will not attract an object if a sheet of any substance is interposed in the air between them, so that in making a test on a compass needle the glass must be removed from the case.

Sealing wax and the other substances which develop the power of attraction attract either end of the magnetic needle.

When a body in which the power of attraction has been developed by rubbing is dipped in water or other liquid it loses the power, being de-energized, and in making the tests, before rubbing an object it should be dipped in water.

Probably all substances which develop the power of attraction do so for some distance beyond the rubbed area. The permeability of some substances is great and rapid, while that of others is limited and slow. In some substances, as glass, it is greater when rubbed with some things than when rubbed with other things.

A stick of sealing wax nine inches long, held by one end and rubbed with flannel at the other end, develops the power of attraction up to the fingers, the energy of the fingers preventing the portion with which they are in contact from developing the energy, and if the stick of wax be then held by the other end, the power will be developed in the portion by which it was held, without additional rubbing.

If a vulcanite comb an inch and three quarters wide and eight inches long, de-energized with water before being rubbed, be rubbed on flannel (wrapped around a ruler) on the back at one end, the end portion an inch in length being rubbed, that portion of

the comb, the teeth included, will develop the power of attraction with little rubbing, but lengthwise beyond that portion the power will be developed for any considerable distance only by prolonged rubbing, the power being eventually developed almost throughout the comb. If the attractive power is then allowed to subside of its own accord, not dipping the comb in water, upon the same end portion being again rubbed, the power will be immediately developed along the comb the same as when last rubbed, the vulcanite being in a state of impressure.

A solid glass sphere two inches and a half in diameter, held between the thumb and forefinger, and rubbed at one place on fur lying flat on the table, develops the power of attraction over the whole exposed surface, and a chemist's glass flask with a spherical body of the same diameter does also, but when the glass sphere or flask is rubbed on flannel it develops the power over a limited area only.

After being rubbed, different substances

retain the power of attraction for different lengths of time. Paraffine will attract the strip of paper after the lapse of many hours, and sealing wax retains the power of attraction for several hours, but vulcanite does not retain it so long.

A solid glass sphere two inches and a half in diameter, rubbed well on fur, retains the power of attraction for over ten minutes, while a chemist's glass flask of the same diameter retains the power for not over two minutes. This shows that the solid glass sphere is energetic throughout.

The energetic condition of a rubbed body is not merely superficial, but the energy permeates, or is developed in the interior of, the body of matter which is rubbed, as shown by the following experiment: Cut a dozen bits of newspaper a sixteenth of an inch square and put them in a chemist's glass flask with a spherical body two inches and a half in diameter. If the flask and paper are perfectly dry, when the flask is revolved the bits of paper fall to the bottom, and

when the flask is shaken back and forth, as if being rubbed on something, the bits of paper fly back and forth.

Rub one side of the flask briskly back and forth on the palm of the hand, and the bits of paper will be seen flying back and forth. After rubbing for a few seconds stop for a moment, giving the bits of paper an opportunity to come into contact with the rubbed portion, after which continue the rubbing, and it will be seen that the bits of paper no longer fly back and forth. After rubbing for a few seconds longer turn the flask over, bringing the rubbed portion uppermost, and it will be seen that the bits of paper adhere to the glass for some time.

If the flask be rubbed at one point on a flat piece of celluloid, so that the rubbing is limited to a small area, when the flask is turned over the bits of paper will adhere to the glass over a small area only, which shows that the charge on the inside of the flask does not get there along the surface, because if it did the bits of paper should

adhere to all parts of the inside surface equally well.

The different effects of rubbing with different substances may be seen by rubbing the flask on fur and paraffine. When rubbed on fur the bits of paper adhere strongly to any part of the flask. When rubbed on paraffine they adhere hardly at all.

That the energy is internal in the matter is also shown by the fact that the energetic body may, through reciprocal induction, be actuated to motion by the energy, which would be impossible were the energy merely superficial. This is shown by the following experiment, which at the same time illustrates the principle of reciprocal induction clearly:

Rub a paraffine candle with the hand until it develops the power of attraction strongly; loop a doubled thread around the middle, and suspend it in a balanced condition from the table.

If any object be held beside one end of the candle that end will move toward it.

Hold a strip of paper, six inches long and a sixteenth of an inch wide, by one end, and after the candle has come to rest bring the free lower end of the paper beside the end of the candle, half an inch from it and edgeways to it, so it will not come into contact with the candle. The end of the candle will move toward the paper.

If the candle be de-energized with water of course it will not be actuated to motion in this manner.

The same experiment may be performed with a magnet, using a steel wire instead of the strip of paper, which shows the similarity of action between magnetism and other attractive energy.

The explanation is that the attractive energy of the paraffine, being transmitted through the air, energizes the paper kinetically, the centroatomic energy being biqualital, and this energy, being transmitted back to the candle, energizes the candle kinetically.

Some substances become charged through contact with a body in which the power of

attraction is developed, and then have the power themselves. If the strip of paper be hung from the edge of an object about two inches above the table, so that the strip is about half an inch out from the edge of the table-top, after the lower portion of the paper has been in contact with a strongly energized piece of sealing wax, the wax being jerked away after contact with the paper, the part of the paper opposite the table-top will fly back into contact with the table-top and will remain in contact with it for some time, showing that the paper has developed the power of attraction throughout its length, and that it retains the power for some time.

When rubbed with certain different substances, some bodies repel each other, as shown by the following experiment: Double a thread and loop it around the middle of a stick of sealing wax which has not been rubbed before, and hang it in a balanced condition from the table; rub both ends of the stick of wax with a clothes brush or

fur, and bring it to a state of rest. Rub another unused stick of sealing wax briskly with a silk cloth, and upon holding this stick beside either end of the suspended stick, that end will be repelled.

If only one end of the suspended stick is rubbed with the brush the other end will be attracted, because the wax will be weakly energized at that end.

If sticks of wax which have been much used in the rubbing experiments are used, the effects of impressure may sometimes be seen, interfering with the experiment.

This experiment shows that the energitia of the wax is affected by the rubbing, and that when rubbed with these different substances the energizativity and energizability are such that repulsion occurs.

The energy developed by rubbing a body which develops the power of attraction is conductible along electric conductors, as shown in the frictional electric machine, in which the energy collected by the combs from the revolving disk is transmitted along wires.

The following experiments are interesting in that they throw a great deal of light on polarity and on the electric circuit:

Heat one end of a copper wire two feet long and a sixteenth of an inch in diameter and stick it in the end of a stick of sealing wax nine inches long, holding it in place until the wax hardens around it. Form the wire into a coil so it will not droop and shake, as it must not be touched with anything when held to the strip of paper.

Holding the wax by the opposite end, rub it briskly for half a minute with flannel, and, holding it by the same end, it will be found that the wire attracts the strip of paper quite strongly.

Take hold at the middle of the stick, encircling it tightly with the thumb and forefinger, and it will be found that the attraction of the wire for the paper is weaker than before. Hold the wax by the end again, and it will be found that the wire attracts the paper strongly again.

This shows that energy passes lengthwise

through the stick of wax, and that it strengthens the energy of the matter at the end in which the wire is fixed. When the stick of wax is held by the middle the energy of the fingers stops the passage of the polar energy, for, as will be seen from experiments hereafter described, a rubbed body has polarity.

The same experiment may be performed with a paraffine candle, a piece of copper wire a foot long being stuck in the end of the candle and coiled, the effect on the paper being more pronounced with the coil.

The candle having been used in the rubbing experiments and having the coiled wire in the end, cut off the point at the other end, and by heating this end with a warm iron and also the end of another candle, the two candles may be joined together, end to end.

Hold the joined candles by the pointed end of the attached candle and rub them throughout their lengths, and it will be found that the wire does not affect the strip of paper.

Take hold of the candles at the point where joined together, encircling them with the

thumb and forefinger, and the wire will then attract the strip of paper.

If the point be cut off of the attached candle and the coiled wire be stuck in that end, the effects will be reversed.

Here again we see that energy must pass lengthwise of the candles, and that it affects the energy of the matter at the ends.

Heat the end of a copper wire two feet long and stick it in the end of a nine-inch stick of sealing wax, and, heating the other end of the wire, stick it in the side of the wax half an inch from the end in which the wire is fixed. Rub the wax with flannel, and the wire will attract the strip of paper.

Now shift the end of the wire in the side of the wax to a point two inches from the other end. Hold the wax by the two-inch end portion, rub with flannel, and it will be found that the portion of the wire near the end of the wax repels the paper, and that the portion near the side of the wax attracts it, while the middle portion has no effect on it.

The opposite qualities of energy are unequal

near the ends of the wire, one quality being stronger at one end, and the other being stronger at the other end, being equal at the middle of the wire, and the energizativity of the resulting centroatomic energy of the wire is such that the paper is affected as stated.

Take hold of the stick of wax at the middle, encircling it with the thumb and forefinger, and it will be found that the portion of the wire which repelled the paper now attracts it, as well as the other portion.

If the end of the wire be pulled out of the side of the wax and be placed in contact with the table or be held in the hand, the wire will not attract the paper, but the portion of the wire near the wax will repel it.

These experiments clearly show that a body in which the power of attraction is developed by rubbing has polarity, and this will be shown more conclusively by an experiment which will be described shortly in connection with conduction.

The experiments also show that in the electric circuit the two qualities of energy act

in opposite directions, which is the essential feature of the circuit.

The energy developed by rubbing is electric energy, for when it is collected by the combs in the frictional electric machine it produces electrical effects, and one of the purposes of these experiments is to show that electric energy is merely the augmented, mannerically modified and polymannerized energy of atomic matter, not essentially different from magnetism or other energy; and to show that it acts in electrified bodies in which it is generated in a certain method, the polar method, and acts in conductors and transmitting media in a certain method, the electric method.

Under the theory it is supposed that the rubbed body in which the power of attraction is developed is energized in the polar method, some of the matter being energized centroatomically, and systems of polar energy being set up in the other kind of matter, acting lengthwise of the body.

The energitia of the matter is affected by

the energy of the matter with which the rubbing is done, as shown by the development of the attractive power in different strengths when the rubbing is done with different substances, and by its nondevelopment when the rubbing is done with some substances. The energy of the matter is augmented by the friction, and so is the energy of the matter with which the rubbing is done; the polymannerism of the energy is increased by the rubbing, and the mannerism of the energy is modified by the augmented energy of the matter with which the rubbing is done.

The centroatomic energizement effected by the rubbing is probably, to some degree at least, comprehensive, and in that way the centroatomic energy is probably extended through the body for some distance, and it is supposed to be extended by the polar energy also.

The centroatomic energy is the energy which effects the attraction and repulsion of bodies, and the transatomic energy in the

medium or conductor is the energy which effects the transmission, being the current energy, the energy of the circuit.

As has already been said, electricity is supposed to be energy, mannerically the same as magnetism, chemicity, heat and light, but certain manners of energy probably produce greater electrical effects than others (28).

Electricity is generated in the dynamo in the presence of electro-magnets; it is generated in batteries through chemical action; it is generated when different metals are placed in contact and heated; it is generated in the frictional electric machine, and it is generated in luminous bodies. Electric energy causes chemical action, causes magnetic action, causes attraction and repulsion, as we have seen in the rubbing experiments, and causes heat and light. Is it not reasonable, then, to suppose that electric energy is mannerically the same as such energy?

Electricity is supposed to be densitic in form of action and biqualital (29).

Electric "waves" are commonly supposed to have long intervals, longer than those of heat, intervals of many feet, even, but it is inconceivable that "waves" of such intervals can incite small bodies and particles of matter, such as atmospheric particles, to centroatomic energy, as is supposed under the theory here advanced, it being supposed that the electricity of wireless telegraphy is diffracted around the earth by this method of energizement, the same as light and heat are diffracted.

In Hertz's experiments the discharges were oscillatory, and oscillatory discharges are used in wireless telegraphy. Under the electromagnetic theory it is supposed that each discharge produces a disturbance in the medium which causes a "wave," the frequency of the "waves" depending on the frequency of the discharges.

Under the theory here advanced it is supposed that the oscillatory discharges produce segregated groups of densits, which may be called Densitries, each densitry

being composed of many densits, and, the energy being polymanneric, consisting of many systems, each of many densits, which are hemispherical in form, and which are imparted to the air by the charged bodies, the conductors and spark terminals.

These densitries follow each other in rapid succession, each discharge producing one, and concordance and interference may occur between the densits of countergressive densitries, as determined by Hertz, and since the concordance and interference between densits of different intervals would be at different points, it is possible, under this theory, to account for the fact that resonators of different sizes have shown the points of intension and vitiation to be differently located.

Electric oscillations occur in a body, such as an electric condenser, which is energetic in the polar method when interruption occurs in the charging current or induction, on account of which there becomes evident a "surging" to and fro of the transatomic

systems, the systems of opposite qualities having opposite directions.

The oscillations are, under the theory, supposed to be due to internal reflections of the transatomic systems, the first of any set being the strongest, the subsequent oscillations becoming weaker and weaker, and finally dying out, just as the internal reflections of light become weaker and weaker and die out. These oscillations probably occur in continuously charged bodies, also, but they are evident only during interruptions.

As Hertz showed, electricity is reflectible, the same as light, and the explanation of reflection given in the next chapter applies to electricity also.

Bodies of some substances obstruct electricity in its transmission through a medium (30). Those substances which do not transmit the energy transatomically obstruct it. If energized centroatomically and comprehensively the energy is transmitted, interatomically, but it is much weakened.

In case of obstruction, however, the energy spreads out behind the obstructing body, being diffracted, just as light is, the diffraction of light being effected through the misceous method of energizement.

Wireless telegraphic messages have been transmitted through the air over distances equal to about a third of the earth's circumference, which shows that the transmitted energy spreads out laterally, or is diffracted around the earth (31).

When standing before a hot fire if the hand is held in front of the face it keeps the intense heat from the face, but considerable heat gets around behind the hand. We all understand how this is accomplished: the air behind the hand is heated, as we say, which means that it is centroatomically energized by the heat.

There is daylight for several hours after sunset, the daylight being due to the centroatomic energizement of the air engaged by the sunlight, the air being energized comprehensively for a long distance, and the

particles of atmospheric dust engaged by the sunlight are energized centroatomically also, and that energy is transmitted transatomically through the air.

Transatomic energy does not spread out laterally to any appreciable extent, and the diffraction of electricity is supposed to be effected by the electric method of energizement, the particles of atmospheric dust with which the air is laden making it energizable in the electric method, and variations in the dust condition of the air may account for the differences in transmissibility of wireless messages at different times.

Not only does the diffraction of electricity depend on the presence of centroatomically energizable particles in the medium, but its very transmission does, as shown by the fact that gases lose their electric conductivity upon being filtered, and in the vacuum discharge tube, which contains ether and some atoms, when the atoms have become diffused the discharge ceases, and it is necessary to inject hydrogen atoms to revive the discharge.

Electric Conduction. It is the common opinion of physicists that the medium or dielectric around a conductor plays an important part in the conduction of electricity (32), which is true, but the conductor is the essential element, as shown by the fact that if the wire be severed and a thin sheet of non-conductive material, such as a disk of paper, be inserted between the ends, the conduction is interrupted, even though the insulation continue unbroken by the point of severance, which clearly shows that the energial action proceeds through the wire. This is also shown by the fact that an excessive amount of impurities in copper wire makes it a poorer conductor. All copper contains some impurities, and a small amount (one or two per cent., say) is probably necessary.

When two different metals, such as copper and zinc or silver and iron, are connected together with a copper wire and suspended in a suitable liquid, forming a voltaic or wet battery, an electric current passes along the

wire and through the liquid between the metals, and particles of one of the metals may be carried over and deposited on the other, as in the electro-plating process, which shows that there is transatomic energy acting around the circuit, the metallic particles being energized in the kinetic method thereby, and from which we see that one quality of the transatomic energy proceeds in one direction in the circuit, and that the other quality proceeds in the opposite direction.

This shows that one of the metals is acting positively in one direction, toward the liquid, and that the other is acting positively in the same direction in the circuit, away from the liquid, each acting negatively in the opposite direction, so that the like qualities in both are acting in the same direction in the circuit.

Under the theory it is supposed that the polar method of energy is necessary in the generating body in order to produce the current of the circuit. That the rubbed stick of sealing wax, the energy of which produces

the electric current, as we have seen from the experiments, has polarity, is shown by the following experiment:

Let the experimenter sit with the strip of paper (or, better, a piece of thread or twine) hanging from the table in front of him; rub a nine-inch stick of sealing wax well with flannel, rubbing the stick throughout its length, and, holding the stick by both ends and crosswise of the thread, bring the middle of the stick squarely to the lower part of the thread.

The thread will be attracted to the middle, and it will then fly toward one end of the stick. If the stick be then jerked away, and the middle be immediately brought to the thread again, the thread will not come into contact with the middle, but it will move toward the opposite end of the stick of wax and come into contact with that part.

This clearly shows that one quality of energy acts toward one end of the stick of wax, and that the other quality acts toward the other end, because the thread becomes

charged when in contact with one end and it retains the charge for a space, and, unlike qualities attracting, since it is then attracted by the other end of the wax, that end must be oppositely charged.

The fact that like poles of two sticks of sealing wax do not repel does not militate against the idea that it has polarity, because the attraction or repulsion depends on the energitia of the matter. If the polar energy does not so modify the energitia of the matter that like poles repel, then they attract.

As to the part played by the surrounding medium in the conduction of electricity: Under the theory it is supposed that the air around the wire is energized transatomically by the centroatomic energy of the particles in the wire, such energy being transmitted by the insulating matter around the wire, if any, so that the wire is surrounded by systems of transatomic energy in the air, which energy is spherical in densitic form, with the point of generation of any system as the centre of that system.

This transatomic energy energizes the particles in the air centroatomically, which centroatomic energy is spherical in densitic form and is transmitted through the air in all directions from the particles in which it is generated, a part of each system proceeding toward the wire, and parts of each system proceeding forward and backward along the wire, energizing other particles centroatomically, and the energy of such particles proceeds in the same way, and so on, and those parts of the systems of atmospheric energy which engage the wire are transmitted through it, engaging all the centroatomically energizable particles in the wire and energizing them, and the energy of such particles builds up and enhances the energy of the circuit.

This is self-induction, accomplished through reciprocal energizement, and it occurs in all electrically charged bodies, it being by this process that charges are maintained or prolonged after electrification has ceased.

By induction, which is accomplished by the surrounding energy in the air, an electri-

cally charged body electrifies a nearby body, in which self-induction then takes place, it becoming surrounded by densition in the air also, and this second body, through such surrounding densition, in turn induces energy in the first body. This action and reaction between bodies is mutual or reciprocal induction.

Conductors and Non-Conductors. Substances which are energizable in the electric method may be classed as conductors of electricity, and the greater the number of manners of energy that the matter acts to in the electric method, the greater its conductivity.

Substances which are not energizable in the electric method may be classed as non-conductors.

Substances which are energizable transmissively or transatomically transmit the energy, but, not being continually built up, it becomes so weak that it soon loses its effectiveness.

Substances which are energizable centro-

atomically transform the energy into heat, light, or chemicity, which process is commonly referred to as resistance, and the fact that some heat is developed even in the best conductors shows that some of the matter is centroatomically energetic.

Iron is a poorer conductor than copper, because more heat is developed in it, more of the electrical manners being transformed into heat, for which reason iron wire may be used for the coil in electric heaters.

THE ELECTRIC SPARK. The electric spark only occurs between two electrified bodies, and the fact that two bodies are necessary shows that the spark is produced by the action of the two systems of energy, the energy of each body being transmitted through the intervening air, the two systems of energy being countergressive, and densitic intersection occurring between them, giving rise to densitic intension and vitiation.

The electric spark suggests the idea that the energy flows from one body to the other

in the form of a narrow stream, but the fact is that the energy is being transmitted in all directions from each body.

The line of the spark is the line of greatest intensity in the electric field, and the spark is evidently caused by the atmospheric particles at the points of densitic concordance of the two countergressive systems of energy becoming luminous on account of the densitic intension resulting from such concordance, the particles being energized centroatomically by the intensified energy.

Lightning is often in the form of an oscillatory discharge, which is evidently due to interruptions in the reciprocal induction between the earth and cloud, the interruptions being caused by the atmospheric particles being actuated to motion through kinetic energizement, resulting, temporarily, in spaces free of particles near the bodies.

The zigzag and tree-like forms of lightning probably result from there being more atmospheric particles along such courses.

Thunder, which is due to the concussion

caused by the violent expansion produced by the lightning, is not a continuous, uniform sound. The variations in the sound are probably due to variations in the number of atmospheric particles along the course of the lightning, the sparser the particles, the less the noise.

Not only are there lines of densitic intension between two electrified bodies, but there are also lines of densitic vitiation.

Photographs of lightning (33) sometimes show black streaks, similar in form to streaks of lightning, and referred to as black lightning, a phenomenon which has not heretofore been explained. The explanation evidently is that they are lines of densitic vitiation, the atmospheric particles along such lines having no luminosity.

There are of course numerous lines of densitic intension between two electrified bodies, and a number of streaks of light can often be seen simultaneously, and since the points of densitic intersection are very numerous and widely scattered, sparking does not

always occur along straight lines between the two bodies, but it may occur along curved or zigzag lines, or along branching lines, variously directed.

CHAPTER XI

THE THEORY OF REFLECTION

HUYGENS'S wavelet theory is commonly applied to account for the reflection of light (34), it being supposed that the wavelets are formed at the reflecting surface, but no explanation has been given as to the cause of the wavelets. The theory is untenable, because the wavelets would give vision of the points at the reflecting surface, and not of the object which is in fact seen by reflected light.

Such wavelets correspond to the densits of colour energy, or analight (35), generated by the superficial atoms of coloured objects, according to the theory of energizement, which theory supposes that the analight by which objects are seen is generated centro-

atomically by the superficial matter under energizement by the light which engages it, the sunlight, daylight, or other light.

The densitic form of analight is hemispherical if the surface of the object is plane or convex, and the analight gives vision in all directions above the surface of each point in the surface.

The fact that the eye must accommodate itself to different distances in looking at objects nearby shows that the densitic curvature in the analight is different from that in the reflected light from a distant source, and this proves that the analight of objects is generated at their surfaces, and that objects are not seen by irregularly reflected light, as is commonly supposed.

If light be reflected from a coloured object, analight from the object will enter the eye with reflected light, and if the incident light be white, the reflected light will be white, and the colour of the object, if other than white, will not be seen.

The superficial atoms are energized by

some of the manners only of the incident light, and the analight from the object includes such manners only. The other manners (except such as are lost through allomannerial energizement) are reflected; and since the analight becomes mingled with the reflected light, the combination of the two gives white. If the reflected light could be separated from the analight, its colour would be found to be complementary to that of the object.

In some cases some of the manners of the incident light are lost through allomannerial energizement, being transformed into heat, and then the reflected light will not have the same colour as the incident light, as, the light from an electric arc lamp reflected from a wet street or sidewalk is lilac coloured.

When light falls on a body of transparent matter, a portion of it is transmitted through the same, and the rest is reflected, the sum of the transmitted and reflected portions being about equal to the incident light.

This shows that some of the manners of

the light are transmitted, and that the other manners are reflected.

Since black matter, which is not energizable centroatomically in the manners of light, reflects light, it is clear that reflection is effected at the surface and in the medium through which the light is transmitted to the surface, and yet surfaces may exist under such conditions that no reflection occurs thereat, as shown by the fact that if two pieces of plate glass, the surfaces of which have been thoroughly cleaned, are put together, face to face, so that the two surfaces are in perfect contact with each other (36), there will not be any internal reflection at the surfaces so in perfect contact, as may be seen by looking at the reflection of a candle flame in that portion of the glass. In that portion only one internal reflection will be seen, being from the back surface of the rear glass, while beyond that portion two internal reflections will be seen, one being from the contiguous surfaces, between which there is air.

This shows that the contiguousness of two unlike media, or two unlike substances, of different energizabilities, is necessary to reflection, and the explanation here given depends on this.

Owing to the preservation of the densitic form, reflected light does not give vision of the reflecting surface, and if no analight emanated from the reflecting body it would be invisible, but there is probably always some centroatomic energizement of the superficial atoms by some of the manners of the incident light or by the light energy of the air, produced by the incident light energizing the atmospheric particles (37).

Under the theory here advanced it is supposed that all the densits which are not spent in energizement, either centroatomic or transatomic, are reflected.

The densits, positive and negative, reach the surface, and those not spent in energizement, being unable to proceed farther, turn back, as it were—that is, a reaction takes place, whereby the dense and rare conditions

produced at the surface by the baffled densits are taken up by the medium in which they occur, and the manners of the reflected light are the same as the baffled manners.

To explain this more clearly: When a positive densit arrives at a reflecting surface, matter moves up against the surface, producing a dense condition thereat, and if it is not taken up by the body of matter at which it occurs, it is taken up by the body of matter in which it occurs, positive equalizing action back into the body of matter taking place, which produces a positive densit in the system of reflected densits. When a negative densit arrives at a reflecting surface, matter moves away from the surface, producing a rare condition thereat, and if it is not taken up by the body of matter at which it occurs, it is taken up by the body of matter in which it occurs, negative equalizing action back into such body of matter taking place, which produces a negative densit in the system of reflected densits.

This is so whether the reflecting surface

be the surface of a solid body, such as glass, the light coming to it through fluid or gaseous matter, such as water or air, or whether it be the surface of a body of fluid or gaseous matter, the light coming to it through solid matter.

The essential thing is that the two substances have different energizabilities, for if they are the same in this respect, since the manners of energy are all transmissible through one of such bodies, they are transmissible through the other also, and none of the manners will be baffled.

This explains why no reflection occurs at the contact surfaces of the pieces of glass in perfect contact, as already mentioned.

If there were a perfect void at the surface of a piece of glass it would be an effectual barrier to all the light coming through the glass to such surface, and all the light would be reflected, because none of it could be transmitted through the void.

The amount of light reflected from the surface of a particular body of matter is not

the same in all media, as, more light is reflected from a piece of glass in the air than from the same piece of glass in water (38).

The explanation of this is, probably, that, owing to the different velocities in the different media, the densitic interval is longer in the air than in the water, the frequency being the same in both media. The difference in interval does not change the manneric character of the light, but it probably affects the energizement.

Each little part of a densit is reflected as it reaches the surface, and the reflection of the entire densitic segment having impact on the surface is a continuous process, from the point of first impact to the point of last impact, so that the same is reflected as a whole, the parts not being reflected independently.

Since the velocity after reflection is the same as before, the densit has the same form after reflection as before, when the reflecting surface is plane, and its curvature is the same as it would be had the original densit pro-

ceeded the same distance without being reflected.

The amount of light reflected is different at different angles of reflection, and it is not the same in this respect from different substances. The light reflected from mercury is about the same at all angles, but with glass the variation is great, being from almost nothing at perpendicular incidence, to almost total reflection at an angle of eighty-nine degrees.

The reason why the amount of reflected light is different at different angles of incidence is, evidently, that the energizativity of the energy is different at different angles of incidence, the greater the angle of incidence, the less the energizativity, and, consequently, the greater the reflection.

Probably the difference in densitic intensity at the different angles of incidence affects the energizativity of the energy, for it is obvious that, as to densits from the same light source, the densitic intensity is greatest at the point where the light falls perpendicu-

larly on the surface, and that the effective intensity rapidly diminishes as the angle of incidence increases. The same size of densitic segment which covers a square inch of surface at normal incidence must cover two square inches of surface at an angle of incidence of sixty degrees, which means that the effective intensity is reduced one half. It is probable that the densitic intensity is a factor in energizement.

It may be, also, that the energizability of the matter at the surface of the body is different at different angles of incidence. Probably the surface atoms are so closely and so evenly packed together that when the densits impinge at an acute angle the atoms are not acted on squarely, and it is supposable that this would interfere with energizement.

Densitional Normalization. The densitional movement in any part of a reflected densit is normal to that part of the densit, just as it was in the densit before reflection, and the densitional movement in any part

of a refracted densit is normal to that part of the densit also. No matter how a densit may change its direction, and no matter how it may be deformed, the action is always normal to the densit, except in polarized densition (see note 3).

Of course the densitional action should be along the line of propagation, because densitic propagation depends on such action, and since densitic deformity results as a consequence of the changing of the directions of propagation of the different parts of a densit, of course the densitional action should, in such case, be normal to the densit.

The maintenance of normality between the densition and the densits may be called Densitional Normalization.

CHAPTER XII

THE THEORY OF COLOUR

PERCEPTION is the discrimination and recognition of the states of energy in the perceptive cells of the brain, which are incited by energy transmitted from the organs of sensation, the organs of sensation being incited to energy by extraneous action, the mental or subjective effect being taken as the external or objective cause.

Light incites the retinal cells to energy, which is conducted along the fibres of the optic nerve to the cells of visual perception in the brain, which are thereby incited to energy, and the different statuses of energy (39) in the perceptive cells are discriminated and recognized as different colours.

We see, therefore, that the different colour

perceptions arise from energial differences, and it must be supposed that the energy of each colour is differentiated at the time it is generated at the external source of generation, for under the principle that like causes produce like effects under like conditions, it would be impossible for the differentiation to occur after the energy is generated.

It is commonly thought that there are three primary colours for light, namely, red, green, and violet, and three primary colours for pigments, namely, red, yellow, and blue. White is not looked upon as a colour at all, being regarded as uncoloured light (40).

Under the theory here advanced all the colours of the spectrum are primary colours, except the green, which does not always occur in the spectrum, and the following are considered to be the primary colours: Red, orange, yellow, chloro (41), glaucous (42), blue, indigo, and violet. All other colours, including white, are compound colours.

No distinction is made between light and colour, for all light is coloured, that is, all

light produces colour perception. Therefore white is a colour. No one doubts that purple is a colour, and purple is the combination of red and violet. Then why should the combination of red and greenish blue, being white, not be a colour? Surely the substitution of greenish blue for violet does not do away with colour.

Under the theory the colours are divided into two classes, positive and negative, depending on the quality of energy which gives the colour: red, orange, yellow, and chloro being the positive primary colours, and glaucous, blue, indigo, and violet being the negative primary colours (43).

The different hues of the positive portion of the spectrum are supposed to be produced by different manners, broadly speaking, of positive light energy, and the different hues of the negative portion are supposed to be produced by different manners, broadly speaking, of negative light energy, and the manners of the two portions are supposed to correspond.

It is probable that the energy of a hue is not in fact monomanneric (44), but for our purposes we may consider it to be so, speaking broadly.

Of the positive colours, red has the lowest densitic frequency; next comes orange; next comes yellow, and then comes chloro with the highest densitic frequency.

Of the negative colours, glaucous has the lowest densitic frequency; next comes blue; next comes indigo, and then comes violet with the highest densitic frequency.

The red therefore corresponds with the glaucous; the orange with the blue; the yellow with the indigo, and the chloro with the violet.

Combinations of the primary colours produce compound colours, which are of two kinds, uniqualital and biqualital. The combination of two or more colours of the same quality, either positive or negative, gives a uniqualital compound colour, and the combination of one or more positive colours and one or more negative colours gives a biqualital compound colour.

Compound colours formed by combining positive colours are Positive compound colours, and those formed by combining negative colours are Negative compound colours.

Biqualital compound colours in which the positive colours predominate are Posito-negative compound colours, and those in which the negative colours predominate are Negato-positive compound colours.

The posito-negative compound colours may be referred to by the general name of the Greens, and the negato-positive compound colours may be referred to by the general name of the Purples.

White is the biqualital compound colour in which the two qualities are equal, being the Equiqualital compound colour.

It is a significant fact that white may be produced by combining colours from the two halves of the spectrum. For every hue in one half of the spectrum there is a complementary hue in the other half, the combination giving white, and the combination of any number of such combinations gives white.

Write the first letters of the words Red, Orange, Yellow, and Chloro- in a line, and below them write the first letters of the words Glaucous, Blue, Indigo, and Violet, thus:

R O Y C

G B I V

Reading vertically we get the complementary colours: R and G, O and B, Y and I, C and V.

Reading downward and to the right we get the purple combinations: R and B, R and I, R and V; O and I, O and V; Y and V.

Reading upward and to the right we get the green combinations: G and O, G and Y, G and C; B and Y, B and C; I and C.

The corresponding combinations of purple and green, as here given, are complementary to each other, as, R-B and G-O, R-I and G-Y, and so on.

The spectrum purple is formed by combining the extreme colours red and violet, and

the spectrum green is formed by combining the extreme colours glaucous and chloro.

Complementarism clearly shows that there is some differentiating feature which divides the colours of the spectrum into two distinct classes, and the only energial feature which has two and only two distinctive characters is the energial quality, there being two qualities, the positive and the negative.

For colours to be complementary to each other they must be mannerically the same, that is, they must have the same densitic frequency, for otherwise one quality will preponderate over the other. If a system of energy of one quality and of one manner, that is, of one frequency, be combined with one of the opposite quality of greater densitic frequency, there will be more densits of the latter system in a given space than of the former, and the more frequent will therefore preponderate over the less frequent. If the densitic frequencies and intensities are the same, the two qualities are equal, and white is the result.

As already stated, green is commonly looked upon as a primary colour. The spectrum purple results from the combination of red and violet, and the spectrum purple and spectrum green are complementary colours. Then, since purple is a biqualital compound colour, its complementary colour (green) must be also. This establishes the compound character of green beyond dispute.

White cannot be produced by mixing substances of complementary colours, but by combining complementary systems of energy, either from luminous bodies or from coloured matter, that is, by combining complementary systems of light or of analight, white may be produced.

The reason why white cannot be produced by mixing pigments of complementary colours is that reciprocal energizement occurs between the substances when mixed, and their energitias are thereby modified, so that when the combined substances are energized by light, neither emits the same analight

that it does when energized separately (45).

We may combine the analight from orange coloured paint with the analight from blue paint, the two paints not being mixed, and the result is white, but when the two paints are mixed, the result is green.

To produce the spectrum purple, lay a strip of black paper or cloth about a quarter of an inch wide on a sheet of white paper, and look at it through a prism from a distance of several feet. The purple will be seen where the violet overlaps the red.

First hold the prism about six inches from the strip, with the apex of the prism uppermost, and the red-yellow colours will be seen above the upper edge of the strip, over the white paper, and the blue-violet colours will be seen above the lower edge of the strip, over the black strip. As the distance between the prism and the strip is increased, the violet widens out more and more toward the red, and when the distance is great enough the violet apparently overlaps the red, producing purple.

The apparent overlapping is accomplished as follows: No colour energy comes from the black strip. The blue-violet colours are segregated, through dispersion, from the composite white analight which comes from the white paper on the near side of the strip, and the red-yellow colours are segregated from the white analight which comes from the white paper on the far side of the strip.

The white analight from the paper is hemispherical in densitic form, and the densitic curvature decreases with distance, becoming less as the densits expand. The angularity between the densits from the opposite sides of the strip also decreases with distance. The densitic curvature and angularity have much to do with refraction and the dispersion of colours.

The violet appears to be over the black strip because the violet densits are so turned by the prism that the densitic incidence (46) on the eye is the same as it would be if the densits actually came from the points where the colour appears to be.

The greater the distance between the paper and the prism, the less the densitic curvature and angularity at the prism, and when the distance is great enough the violet densits are so turned that they have incidence on the eye the same as they would have if they came from the points where the red densits come from, which means that they are parallel with the red densits, and they therefore reach the same retinal cells that the red densits do, and the two systems of densits are thereby combined in the retinal cells.

Now lay a strip of white paper about a quarter of an inch wide on a piece of black cloth. Upon looking through the prism at the strip from a distance of about six inches the red-yellow colours will be seen above the lower edge of the strip and over the strip, and the blue-violet colours will be seen above the upper edge of the strip and over the black cloth. As the distance between the prism and strip is increased the chloro approaches the glaucous, and when the distance is great

enough the chloro overlaps the glaucous, apparently, producing green.

Let the sun shine through the prism and let the spectrum fall on a piece of white paper on the floor (47). When the distance between the prism and paper is not great, the divided spectrum will be seen, the two sets of colours, the red-yellow set and the blue-violet set, being separated by a white stripe, and no green will be present. As the distance between the prism and paper is increased, the white stripe becomes narrower and narrower, and finally the chloro apparently overlaps the glaucous, and the green appears.

The chloro does not in fact overlap the glaucous. In the case of looking through the prism at the strip of white paper, the white between the two sets of colours is the result of the combination of all the colours. As the distance between the prism and paper is increased the densitic curvature and angularity decrease, and the densits which, after refraction, were parallel, and which, on account of being parallel, produced the

white combination, are differently refracted and thrown out of parallelism after refraction, and the white combination is gradually broken up, the negative colours being gradually eliminated from the lower portion of the white, leaving the positive colours, and when the distance is great enough the white entirely disappears, chloro and yellow having taken its place. With a further increase in distance a new combination arises between the chloro and glaucous, the densits of which become parallel, giving the spectrum green.

In the case of the spectrum produced by the sunlight, the densitic curvature being inappreciable, owing to the great distance of the sun, the refraction and dispersion are at maximum, and on the other side of the prism the densits of the different colours have divergent directions, and when the distance between the prism and paper is great enough they fall on the paper at different points, all not falling together at any point, so that there is no white, but when the distance is short all the colours fall together on the paper

at the middle of the spectrum, producing white, as explained in note 47.

As to the elimination of one of the qualities of the energy: Under the theory it is not supposed that the two qualities of densits of the same system are separated and transmitted separately in order to produce the two qualities of colours, but it is supposed that one of the qualities in each case is eliminated from the light mannery by allomannerial energizement, being the disqualital method of energizement.

In the case of a positive colour the negative quality is thrown into the heat or chemical mannery, and in the case of a negative colour the positive quality is thrown into one or the other of such manneries, so that while the two qualities in any case still accompany each other, only one of them belongs to the light mannery, and therefore only one of them is effective for vision.

Since both qualities of energy are present, light in which either quality of colour preponderates, when transmitted transatomi-

cally, does not produce motion, which it would if one quality were absent, although some matter may, under some conditions, be energizable kinetically by some of the manners of light (48).

CHAPTER XIII

THE THEORY OF DOUBLE REFRACTION

AS is well known, many crystalline substances, such as Iceland spar, are doubly refractive, that is, when a beam of light is transmitted through them it is divided into two parts, which are differently refracted, or transmitted in slightly different directions, and when we look through such a crystal objects are seen double.

That double refraction depends on differences in the velocities of the two parts of light in the crystal is so well known as to require no consideration here. Suffice it to say, that if we suppose the light to be generated at a point in the crystal, so that it would proceed in all directions from the point of generation, the densitic form of one

part of the light (the part which is referred to as the ordinarily refracted part) would be spherical, and the densitic form of the other part (which is referred to as the extraordinarily refracted part) would be ellipsoidal, the ellipsoidal form being due to the fact that that part of the light has different velocities in different directions through the crystal. In some crystals (Iceland spar, for example) the lowest velocity of the ellipsoidal densits agrees with the velocity of the spherical densits, while the higher velocities of the ellipsoidal densits are greater than the velocity of the spherical densits. In other crystals (quartz, for example) the highest velocity of the ellipsoidal densits agrees with the velocity of the spherical densits, and the lower velocities are less than the velocity of the spherical densits. And in other crystals (topaz, for example) the lowest velocity of the ellipsoidal densits is less than the velocity of the spherical densits, and the highest velocity is greater than the velocity of the spherical densits.

Under the undulatory theory of light it is supposed that double refraction is due to the ether around the molecules in the body having different degrees of elasticity in different directions, and to the light having transverse vibrations in different directions, the vibrations of one direction being ordinarily refracted, and the vibrations at right angles thereto being extraordinarily refracted, the two parts of light being thereby polarized, that is, the transverse vibrations of different directions being segregated.

Under the theory here advanced the crystal (the atomic matter) is supposed to have different degrees of elasticity in different directions, and on this account some of the manners of light, of both qualities, have different velocities in different directions through the crystal, while the other manners, of both qualities, have the same velocity in all directions. Double refraction is not supposed to depend on polarization.

Tourmaline is especially adapted for showing the supposed dependence of double

refraction on polarization. Some of the varieties of tourmaline are both transparent and translucent, the part of light which is transmitted being extraordinarily refracted, and the other part being spent in centro-atomic energizement, causing the translucency, but in the dark variety (commonly used for tourmaline tongs) the centroatomic energizement is allomannerial (49), so that the crystal is not translucent, and the transmitted light is weak, showing that more than half of the light is lost through allomannerial energizement.

If two plates of tourmaline, cut in a certain way as to the optic axis of the crystal, are placed together, face to face, with their optic axes parallel, the extraordinarily refracted light will be transmitted through both, but if one of the plates is turned through ninety degrees, no light will be transmitted through the second plate (50).

When two plates of other doubly refractive substances are used all or nearly all the light is transmitted through both plates, however

turned, the division of the light into parts not perventing its transmission, showing that the extinction of the light in tourmaline depends on the peculiar energizability of that mineral.

With the infra-red rays (heat rays) Iceland spar acts like tourmaline does with light (51), which shows that polarization has nothing to do with the extinction of the light in tourmaline, but that the energizability of the matter and the mannerism of the energy are the all-important factors.

Under the theory it is not necessary to suppose that the densitional movements in either the original light or the light transmitted through the first plate of tourmaline are other than in the lines of propagation. It is only necessary to take into account the fact that the light transmitted through the first plate reaches the second plate at an angle. It is not even necessary to suppose that the light be polarized, although of course it may be polarized.

The incidence of the light on the second plate being at an angle, and the densitic

movements being in the line of propagation, when the plates are crossed, the molecules of the second plate are presented to the densition in a certain way with regard to some directional peculiarity of the molecules.

All doubly refractive matter is molecular, and it may be that the different kinds of atoms in the molecules are arranged in a certain way with regard to the crystal form.

That the energizing effects of light at different angles of incidence are different is seen in connection with the reflection of light, and it is also shown by the following experiments:

The room being darkened by pulling down the window curtains, make a hole about a sixteenth of an inch in diameter in a curtain, the hole to be about six inches above the top of a table or stand.

Place the stand close to the window, and, propping a book up at an angle of about forty-five degrees on the stand, place a piece of quarter-inch plate glass, about four inches square, on the inclined book, the glass to be within a foot of the hole in the curtain.

Two bright images of the illuminated hole will be seen upon looking at the glass, the light for one being reflected from the upper surface of the glass, and the light for the other being reflected at the lower surface of the glass. A faint image, produced by a second internal reflection, will also be seen.

Keeping the glass on the book, turn it around, and it will be seen that the images maintain their relative positions during the entire rotation, none of them being perceptibly dislocated.

Now lessen the angle of inclination of the glass to about twenty degrees with the top of the stand, and upon rotating the glass as before it will be seen that the images produced by the internal reflections change their positions somewhat as to the image produced by the external reflection, moving around in little orbits, with the externally reflected image outside thereof.

Now repeat the experiment with the glass horizontal, and it will be seen that the movements of the images produced by the internal

reflections are greater than before. They move in elliptical orbits, and at one position they coincide with the externally reflected image.

Now move the stand back about seven feet and repeat the experiments with the glass at the different angles, and it will be seen that the movements of the internally reflected images are much greater than they were close to the window. With the glass inclined at forty-five degrees they move in quite large orbits, coinciding at one point with the externally reflected image, and at the lower angles of inclination they move in elliptical orbits around the externally reflected image, passing close by its sides.

At a distance of fourteen feet the effects are still more pronounced.

Now move the stand close to the window again, and use two pieces of plate glass, placing one on top of the other, and having the book inclined at an angle of about forty-five degrees. A number of internally reflected images will now be seen, and upon turning the glasses around together it will

be seen that the weak internally reflected images have considerable movement, the strong ones remaining stationary.

These experiments show several things: They show the effect of structural peculiarities, for plate glass is rolled and its structural character is not the same in the direction in which it is rolled as at right angles thereto; they show that the effects are different at different angles of incidence, and they show that the effects are different with different intensities of light, for in the experiments the light has different intensities at the different distances.

The image produced by the externally reflected light remains stationary, because that light is not affected by the structural peculiarities of the glass. Its densitic form is that of a spherical segment.

When the other images remain stationary during the rotation of the glass, the densitic form of that light is also that of a spherical segment, but when they change their positions during the rotation, the densitic form of the light is that of an ellipsoidal segment.

CHAPTER XIV

THE THEORY OF POLARIZATION

IN 1678 Christian Huygens, a Dutch physicist, advanced the first vibratory theory of light, which is commonly referred to as a theory of longitudinal vibrations, that is, vibrations in the directions of the lines of propagation.

In 1669 Bartholinus discovered double refraction, and in 1690 Huygens, while investigating the phenomenon, discovered that the two parts of light transmitted by Iceland spar were different in a way, being, as we now say, differently polarized.

Huygens was not able to explain polarization by his theory of light, and in order to explain it, Fresnel advanced the theory of transverse vibrations, the present undulatory

theory, which, because it affords an explanation of polarization, has become the accepted theory (52).

Polarization, therefore, is a very interesting subject here, for the idea of transverse vibrations does not enter into the theory of energy herein advanced, although, as will be seen, the densitional movements are, under the conditions under which polarization occurs, naturally at angles to the lines of propagation.

The accepted theory is that the vibrations in common or unpolarized light are in all directions transverse to the lines of propagation (53), and that when the vibrations do not occur in all such transverse directions the light is polarized.

Polarization occurs in reflected, refracted, and diffracted light; the skylight is polarized, and so is the light which comes obliquely from a luminous body (54).

Under the theory here advanced light is supposed to be polarized when the densitional movements are not parallel with the lines

of propagation, not normal to the densits. In other words, polarization is densitional denormalization, the denormalization being caused by densitic intersection.

When the densits of different systems intersect each other at an angle, since the matter cannot move in the several directions simultaneously, it moves in a single direction, in what may be called the line of the resultant, and in this connection the relative intensities of the intersecting densits must be taken into account.

This denormalization of the densitional movements as to all or some of the intersecting densits is supposed to be polarization of such densits.

POLARIZATION OF LIGHT PROPAGATED OBLIQUELY FROM A LUMINOUS BODY. If we let the altitude of an isosceles triangle represent a line of propagation of one system of densits, and let the two equal sides of the triangle represent lines of propagation of two other densitic systems, the densits of the three systems intersecting at the apex of

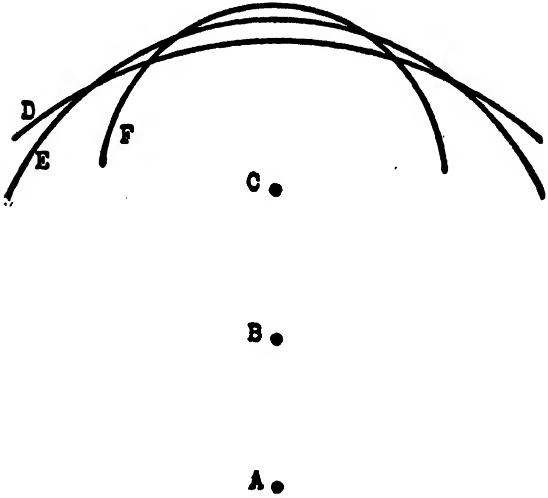
the triangle, the densits proceeding along the altitude would not be polarized, because that would be the line of the resultant, but those proceeding along the sides of the triangle would be polarized at the point of intersection, and they would be densits propagated obliquely from the luminous body from which the three systems of densits are supposed to have come, a luminous sphere, say.

In such a case the densitional movements at the points of intersection are normal to the densits propagated along the normal lines, but not to those propagated along the oblique lines.

Polarization of the Skylight and of Diffracted Light. As has been explained, the skylight is supposed to be the centroatomic energy of the atmospheric particles under energizement by the sunlight, and diffracted light is supposed to be the centroatomic energy of the atmospheric particles also.

In both cases the densitic form is spherical, and the densits expand as they proceed from

their respective points of generation, and those from the various points of generation intersect each other, and such intersection, under the theory, causes polarization, as illustrated in Drawing A, in which the dots



DRAWING A.

A, B, and C represent three atmospheric particles, and the arcs D, E, and F represent segments of spherical densits generated at the particles, respectively.

Owing to the different distances over which these densits have proceeded, they have different curvatures, so that they intersect each other, as shown, the lines of intersection being circular. Of course it is not necessary that the atmospheric particles should be in a line in order for the densits to intersect.

The densits have the same velocity, and as they proceed they maintain their relative positions, and, though their curvatures become less, they continue to intersect each other.

Since the matter at a point of intersection cannot move in two diverse directions simultaneously, the line of movement, being the line of the resultant, is not normal to either of the intersecting densits.

To get an idea of the intersections occurring throughout the expanse of any densit, it is only necessary to imagine a continuous series of densits proceeding away from each atmospheric particle, and this may be illustrated by describing a great number of con-

centric circles, close together, around each of the dots A, B, and C.

POLARIZATION OF REFLECTED AND REFRACTED LIGHT. It is a significant fact that light which is reflected from the surface of an opaque body is not polarized, a transparent body in which internal reflection may occur being necessary, although the analight from an opaque body may cause slight polarization of the light reflected from such a body.

Light which is reflected perpendicularly, or which is transmitted perpendicularly is not polarized. Only light which is reflected or transmitted other than perpendicularly is polarized, and the polarization increases, qualitatively, as the angle of incidence increases, reaching a maximum at some angle, referred to as the polarizing angle, after which it decreases.

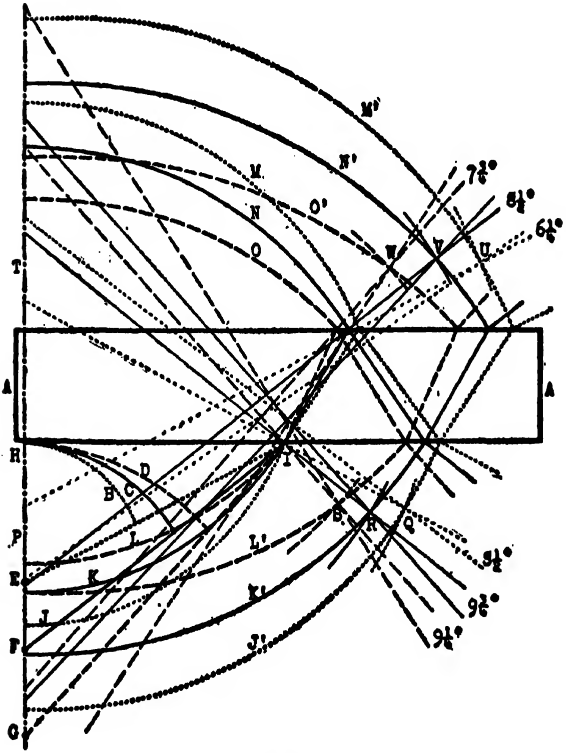
The polarizing angle is different with different substances, depending on the velocity of the light in the substance. With glass it is 54½ degrees. There is no good

explanation of this under the theory of transverse vibrations, but the reason is obvious under the explanation of polarization here given, for it is at once clear that, in the case of reflected light especially, since the velocity of the light in the substance affects the polarization, light which has travelled in (been internally reflected in) the substance must play a part in the polarization.

Under the theory it is supposed that the polarization of reflected light is due to the intersection of the several densitic systems produced by the external and internal reflections, and that the polarization of refracted light is due to the intersection of the several densitic systems in the transmitted light, the system transmitted directly and the systems resulting from internal reflections.

The manner in which polarization in reflected and refracted light is effected is illustrated in Drawing B, in which AA represents a piece of plate glass (edge view), and the dotted arc B, the solid arc C, and the dashed

arc D represent segments of densits generated at points E, F, and G, respectively.



DRAWING B.

The dotted lines throughout the drawing

pertain to densit B, the solid lines to densit C, and the dashed lines to densit D.

These densitic segments will impinge on the glass between points H and I, the line EI indicating an angle of incidence of densit B of 64½ degrees; the line FI indicating an angle of incidence of densit C of 54½ degrees, and the line GI indicating an angle of incidence of densit D of 44½ degrees, the three angles of incidence being given for the purpose of comparison.

There will be external reflections between points H and I, the arcs J, K, and L representing densits of the externally reflected lights. There will also be a number of internal reflections, the curves J′, K′, and L′ representing densits of systems resulting from the first internal reflections.

The curves M, N, and O represent densits of the three systems of light transmitted directly, and the curves M′, N′, and O′ represent densits of systems which have been internally reflected and transmitted.

The internal reflections increase in number

as the angle of incidence increases, and the systems in the reflected and transmitted light increase accordingly. In the drawing only one system is shown on each side of the glass in each of the three cases as resulting from internal reflection.

It will be seen that the corresponding curves J and J′, K and K′, L and L′ are not parallel, so that, there being a continuous series of densits of each kind proceeding away from the glass, the densits of the two series in each case will intersect, those of the J and J′ series intersecting each other; those of the K and K′ series intersecting each other, and so on.

There will not be any intersection along the normal line P, because the densits of the different series are parallel along that line.

By carrying portions of the arcs J, K, and L normally outward to intersect the curves J′, K′, and L′, respectively, as shown at Q, R, and S, the angles of intersection of the two series of densits in each case may be determined, and it will be seen that the angle of

intersection is greatest at R, between the densits reflected at an angle of 54½ degrees.

The angles of intersection in the three cases, as shown by the radial lines, are: At Q, about 8½ degrees; at R, about 9¾ degrees, and at S, about 9¼ degrees.

It will be seen that the corresponding curves M and M′, N and N′, O and O′ are not parallel, so that, there being a continuous series of densits of each kind proceeding away from the glass, the densits of the two series in each case will intersect, those of the M and M′ series intersecting each other; those of the N and N′ series intersecting each other, and so on.

There will not be any intersection of the transmitted systems along the normal line T, because the densits of the different series are parallel along that line.

By carrying portions of the curves M, N, and O normally outward to intersect the curves M′, N′, and O′, respectively, as shown at U, V, and W, the angles of intersection of the two series of densits in each case may be

determined, and it will be seen that the angle of intersection is greatest at V, between the densits refracted at an angle of 54½ degrees.

The angles of intersection in the three cases, as shown by the radial lines, are: At U, about 6¼ degrees; at V, about 8½ degrees, and at W, about 7¾ degrees.

We therefore see why there is an angle of maximum polarization, qualitatively, in reflected and refracted light, and why the angle varies with the velocity.

With a single plate of glass the reflected and refracted lights are only partially polarized, quantitatively, but with a number of plates together both the reflected and refracted lights become completely polarized, quantitatively (55).

The number of systems of reflected and refracted light of course increases as the number of plates of glass increases, owing to the number of internal reflections increasing, and as the number of systems of light increases, the densitic intersections increase.

Hence the increase in quantity of polarization.

Complete polarization obtains when the densitional denormalization is continuous along the densits, necessitating very numerous densitic intersections.

To understand that polarization is due to densitic intersection, it is only necessary to consider that the light reflected externally and internally from the first plate of glass is present however many plates are used, and these portions make up quite a portion of the total light reflected from all the plates, and since that portion would be only partially polarized, complete polarization of all the reflected light would be impossible unless that portion be further polarized by the light reflected from the other plates. The same reasoning applies to the transmitted light also.

The same principle of densitic intersection applies in double refraction, for not only do internal reflections occur in both parts of the light, giving rise to densitic intersection,

but the densitic forms of the two parts of light being different, intersection occurs between the densits of the two parts, on which account the polarization may be even more pronounced than in simple refraction.

Other forms of energy are polarizable also, and it is supposable that polarization may be produced by the intersection of densits of different manneries, as, heat may polarize light. Analight may also polarize to some extent the light reflected from the surface of the body from which the analight emanates.

Now, when we consider that densits have various forms, curved and plane, ordinarily spherical, but variously deformed by refraction and also by reflection from irregular surfaces, we see how the lines of densitic intersection may be different in different cases: they may be circular or elliptical or otherwise curved, or they may be straight, and different parts of such curves have different directions.

In considering energizement in polarized light, the direction of the denormalized

densition must be taken into account, for if a polarized densitic segment impinge normally on a surface, the densitional movements will not be normal to the surface, and, on the other hand, a polarized densitic segment may impinge on a surface at an acute angle, and the densitional movements may be normal to the surface.

CHAPTER XV

THE THEORY OF EDGETAL DEFLECTION

AS has already been said, the diffraction of light, and of other forms of energy also, is effected by the centroatomic energizement of particles in the medium through which the energy is being transmitted.

This is not deflection of light from a luminous body, nor is the atmospheric light actually turned out of its course, for, that light being spherical in densitic form, portions of the densits naturally proceed behind the obstructing object, but, as shown by the following experiments, certain portions of the densits of the daylight are deflected when the light passes by two edges, and certain portions of the light from a luminous body are deflected at edges of objects by which the light passes.

On the floor by a window through which the skylight (not sunlight) is entering place a sheet of white paper, and on the paper, opposite the middle of the window, lay a book (an inch and half thick) on its side, with the front edges turned from the wall, parallel therewith, and about eighteen inches therefrom, the height of the window ledge above the floor being about two feet. Raise the lower half of the window, so its lower sash will be out of the way, and draw the curtain until its lower edge is about eighteen inches above the window ledge. The curtains of any other windows to the room should be closed.

It will be seen that the book casts a shadow on the paper about three quarters of an inch wide, and a close study of the shadow will reveal the fact that the shadow is darkest at the border, which fact is also shown by the extension of the border portion at each end as a narrow dark space. By using a fine thread it will be found that the edge of the curtain, the edge of the book, and the dark space are in line.

About three eighths of an inch from the border of the shadow, and parallel therewith, will be seen a narrow bright streak, and by using the thread it will be found that the edge of the window ledge, the edge of the book, and the bright streak are in line.

In order to produce either the dark space or the bright streak with the skylight the light must pass by two edges, as by the edge of the curtain and the edge of the book, or by the edge of the window ledge and the edge of the book. They do not occur when the skylight passes by one edge only, but they do occur when the sunlight, or the light from a candle, passes by a single edge.

Place a sheet of white paper on the floor where the bright sunlight coming through a window will fall on it, and hold a ruler at a distance of about three feet from the paper so that one end will cast a shadow on the paper. A bright streak and dark space will be seen at each side of the shadow. Hold the ruler vertically a few inches from a candle flame so that one edge and the end will cast a

shadow on a piece of white paper held at a proper distance beyond, and the dark space and bright streak will be seen.

In the case of the sun, the bright streak will be in line with one side of the sun, and the dark space at the border of the shadow will be in line with the other side of the sun. In the case of the candle flame, the bright streak will be in line with one side of the flame, and the dark space at the border of the shadow will be in line with the other side.

The densitic form of the skylight is spherical, the densits being generated at the atmospheric particles, and when the spherical densits pass by the edge of the window curtain or the edge of the window ledge they are severed, and thereafter each densit has a definite edge. The densits of the skylight are generated at all points outside the window, so that the bourn (56) of many of the densits severed at the curtain is a plane between the edge of the curtain and the edge of the book, and the bourn of many of the densits

severed at the window ledge is a plane between the edge of the window ledge and the edge of the book, the edges of such densits in both cases passing by the edge of the book.

It is probable that there is some condition of the medium (57), such as greater density, at and near the surface of an object (the density gradually increasing toward the surface over a short distance, being greatest at the surface), which has a turning effect on the edge portions of the densits passing through the same, the densitic velocity decreasing as the density of the medium increases, which causes such edge portions to be deflected from their straight courses. This is probably the explanation of the phenomenon.

We see the limb of the sun by means of the edge portions of the hemispherical densits coming from the points in the sun's limb, and we see the sides of a candle flame by means of the edge portions of the hemispherical densits coming from the points in the sides of the flame. Such being the case,

the edges of many densits from opposite portions of the sun's limb, or from opposite sides of the candle flame, will pass by the edge of an object exposed to the light in either case, and the edge portions of such densits will be deflected in the same manner that the edge portions of the densits of the daylight severed at the window curtain and window ledge are.

This deflection of edge portions of densits may be called Edgetal Deflection. The bright streak may be referred to as the Deflection Streak, and the dark space may be referred to as the Deflection Space.

Leaving the curtain as it is, pull the window down until the top of the sash is three or four inches below the lower edge of the curtain, and a narrow dark space will be seen between the shadow of the book and the deflection streak, and parallel with the same.

This dark space is not a shadow of the window sash, because the skylight has all directions and does not give a definite shadow in any single direction. It is a deflection

space, the edge portions of the densits severed at the edges of the window sash being deflected in toward the shadow of the book, making a well illuminated strip along its border, and leaving the dark space.

In the same manner the deflection space along the border of the shadow of the book results from the light being deflected into the shadowed field, making the back portion of the shadowed field lighter than the front portion.

The deflection streak is produced at the expense of the illuminated field beyond, but owing to the general illumination of that field, the slight loss of light from it is not detectable, evidently.

When light from an aperture passes by the side of an object, a narrow bright streak and dark space may be seen near the margin of the shadow on the screen on which the light falls, and if any of the light come from the side of a flame, the relation between the side of the aperture and the side of the object being right, several streaks and spaces

may be seen, for, these being deflection streaks and deflection spaces, not only do the edges of the aperture produce densitic edges, but the hemispherical densits from the side of the flame have edges, and the edge portions of some of such densits may be deflected at the side of the aperture, and the edge portions of others may be deflected at the side of the object.

These bright streaks and dark spaces are commonly referred to as diffraction bands, and they are supposed to be due to interference in the diffracted light (58), but, as we have seen, they are not so produced.

Interference may occur between the densits of diffracted light, being the light of atmospheric particles, but the lines of vitiation are extremely fine, and only under certain conditions is the effect apparent. The effect of interference between densits of the daylight, which is the same as diffracted light, may be seen in the following experiment:

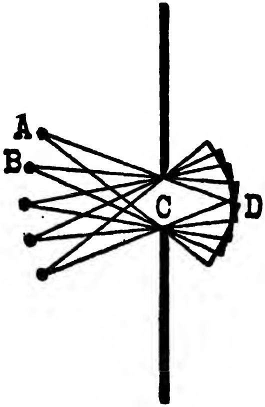
On one side of a small piece of window glass spread with a knife some thick black paint (artists' paint, contained in a tube). Make a slit, an eighth of an inch long, in the paint with the point of a pin—a single scratch.

Upon looking through the slit at the bright sky, holding the slit close to the eye, with the eye wide open, so the eyelashes will not interfere, hundreds of fine dark parallel lines will be seen. If the experiment is properly performed the individual lines can be seen.

These are undoubtedly lines of densitic vitiation, caused by interference between densitic segments of the daylight, as illustrated in Drawing C, in which dots A, B, and so on represent atmospheric particles, the space C represents the slit, and the arcs at D represent segments of densits generated at the atmospheric particles and which have passed through the slit, the straight lines between the dots and arcs being bournal lines (see note 56), representing the courses

along which these segments have proceeded.

It will be seen that there is angularity between these segments, on account of which



DRAWING C.

they intersect each other, causing densitic interference and vitiation, as well as densitic concordance and intension.

This experiment affords further proof of the theory of energizement, for it shows that the densits of the daylight are generated at the atmospheric particles, being spherical in form.

The lines can also be seen, but not so clearly, by looking through the slit at a candle flame or other light (59).

Lateral Stripes. Upon looking through a narrow slit at a light, coloured stripes will be seen at the sides of the light, and these are commonly referred to as diffraction bands also (60), but, as will be seen, they do not result from interference in diffracted light, and so it is more appropriate to call them, simply, Lateral Stripes.

In a room otherwise dark, look at a candle flame through the slit in the paint on the glass made with the point of a pin. With the glass at a distance of a foot from the flame, laterally extending streamers of white light will be seen, and near the flame, at each side, will be seen two or three sets of narrow stripes, each set containing a green and a purple stripe, the green on the side toward the flame, and the purple on the other side. Each set has an outline similar to that of the flame, which tapers toward the top and bottom, so that there are intervening dark

spaces at the top and bottom, the middle portions overlapping at this distance.

As the distance between the flame and glass is increased, the stripes and spaces become wider, and the flame becomes wider, and red borders appear at its sides.

Change in the distance between the eye and the glass does not affect the stripes.

The eye may be moved to one side until the flame cannot be seen, and yet stripes on one side can be seen.

Make a wider slit in the paint by dragging the head of a pin through it, after the manner of dragging a hoe, and upon looking through this, with the glass about four inches from the flame, white lateral streamers will be seen, but there will not be any stripes. With the glass a foot from the flame there will be seen at each side of the flame, and near it, two or three narrow streaks of light, with dark spaces between, and as the distance between the flame and glass is increased these streaks become wider and the green and purple stripes become distinct in them.

The lateral streamers will also be seen, and, especially with the glass at a distance of two feet from the flame, it will be seen that the streamers are striped (in addition to the stripes already mentioned), the stripes being rather indistinct.

If the slit be turned obliquely, the stripes remain vertical, parallel with the flame, which shows a relation between the stripes and the principal image of the flame, which of course is vertical, however the slit may be turned. If the stripes were the result of interference in diffracted light, they would be parallel with the slit at all times.

The lateral stripes cannot be seen on a screen back of the slit, which shows that the phenomenon is produced in the eye, and the reasonable explanation is that the stripes are caused by deflected edge segments of densits being internally reflected in the lens of the eye, and this conclusion is supported by the following experiment:

Hold the end of a slender opaque object, such as an unsharpened lead pencil, hori-

zontally in front of the candle flame and half way across the flame, and upon looking through the slit made with the head of the pin it will be seen that the pencil produces effects on both sides of the flame. The effects can be best seen with the glass about two feet from the flame.

It will be seen that there are stripes over (extending across) the pencil, and that while there are stripes in line with the pencil on the other side of the flame, the spaces between them are wider and darker than above and below. It looks like a shadow of the pencil extending on the other side of the flame.

The colours of the stripes over the pencil and in line therewith on the other side of the flame are much more distinct than are the colours above and below, the stripes above and below being much paler, as a result of the coincidence of colours nearly complementary.

The stripes over the pencil are not in line with those above and below, and the inner set of stripes is within the line of the flame.

The explanation of this evidently is that, the stripes being produced by internally reflected edge segments of densits in the lens of the eye, since the lens is convexo-convex, a densitic segment deflected back of the iris at one side of the pupil will be internally reflected several times in the half of the lens on that side, and it will then be internally reflected backward across the centre into the other half of the lens, where it will be internally reflected several times.

Of course some of the internally reflected light escapes, as it were, from the lens at each reflection, and so some of the light from the reflections in the central portion of the lens reaches the retina within the area where the flame is imaged, the stripes seen over the pencil within the line of the flame being so produced.

The stripes seen over the pencil are produced by internal reflections backward from the other side of the lens, and the stripes which are cut out on the other side of the flame are produced by internal reflections backward

across the centre of the lens from the side on which the pencil is, but that light being now obstructed by the pencil, such internal reflections do not occur; hence the dark spaces.

It is reasonable to suppose, also, that the colours are segregated by the lens, just as a raindrop segregates the colours of the rainbow, the light being internally reflected in the raindrop.

The fact that lateral stripes on one side can be seen when the flame is out of sight, the eye being to one side, shows that the edge portions of the densits from the side of the flame are deflected into the eye from the side of the slit toward the eye, and it is easy to see how these narrow segments, deflected at the edge of the iris and internally reflected in the lens, produce the lateral stripes.

A liquid is evidently more dense at and near a solid surface, the same as a gas is. That there is attraction between solid matter and adjacent liquid is shown by the meniscus which is seen on the surface of a liquid against

a solid, and such attraction must cause condensation of the attracted liquid.

The angle of incidence of the densits on the eye, and, consequently, of the deflected segments on the lens, changes with the changing of the distance between the flame and the slit, which, evidently, accounts for the different effects at different distances.

Undoubtedly some of the light entering into the streamers is generated by the atmospheric particles between the flame and the slit, because such particles are energized by the candlelight, as shown by the fact that the fine lines of vitiation can be seen when looking through the slit at the flame, the same as when looking at the clear sky, as heretofore explained.

In a preceding chapter the spurious star-disk was mentioned, and the phenomenon was said to be due to internal reflection in the lens of the telescope. The explanation commonly given is that light cannot be focussed to a geometrical point.

Undoubtedly there is a limit to the extent

to which a densitic segment can be reduced, but since the size of the spurious disk is different with lenses of different sizes, the larger the lens, the smaller the disk, it follows that the spurious disk to some extent depends upon something which takes place in the lens.

The spurious disk, as seen with the telescope, is surrounded by several rings, which are probably deflection streaks, produced in the eye, as shown by the following experiment, which also throws some light upon the cause of the spurious disk:

Spread some thick black paint on one side of a piece of window glass about an inch square, and in the morning when the sun is about 30 degrees above the horizon place the glass on edge on top of the upper sash of the lower half of a window through which the sun is shining at an angle from one side, the glass to be held at right angles to the line of sight, and the line of sight to be about 45 degrees from the sun, to one side. With the painted side of the glass away from the eye, hold the eye about an inch from the glass, and look

squarely at the glass, holding the eye wide open, so the sunlight will strike the cornea.

A bright circular image will be seen with dark spots floating across it. The outer portion of the image-disk appears to be made up of a number of concentric rings, separated by very fine, dark lines (circles), showing, evidently, how the image-disk is increased in size by the addition of the rings, which are probably produced by internal reflections.

It will also be seen that each dark spot is surrounded by dark rings, which are probably deflection spaces, and which correspond to the deflection streaks seen around spurious disks.

If the glass is held just right a reflection of the image may be seen a short distance below, and multiple images of the dark spots, due to internal reflections, may be seen.

Deflection-points or Star-points. The light from a spherical body, such as a star, is full of densitic edges, the limb of such a body being seen by means of the edge

portions of the hemispherical densits generated at the points in the limb, and it is supposable, from what we have seen in our experiments, that the points of light which seem to project from a star or other light at night, and which may be referred to as Deflection-points or Star-points, are due to the presence in the light of densitic edges, the edge portions of densits being severed at the iris, and the densitic segments thus formed being deflected back of the iris.

Each person sees the points of light projecting in certain directions, and he always sees them projecting in such directions, which is probably due to slight irregularities in the edge of the iris, recesses or indentations being very favourable to their production.

TWINKLING. Some suppose the twinkling of the stars to be due to interference (61), while others consider it to be due to inequalities in the density of the earth's atmosphere, causing parts of the light to be refracted this way and that, being thereby

intensified at places, and diminished in intensity at other places (62).

It is remarkable that the fixed stars, which are suns, twinkle much more than the planets, which usually do not twinkle, although they do at times, and this leads us to consider the difference between a planet and a sun with reference to the radiation of light.

The light of a sun is generated in the photosphere and is transmitted through the chromosphere, while the light of a planet (except that of Mercury and Mars) is radiated by its atmosphere without being transmitted through the same to any great extent. In the case of Mercury, the light is radiated by the solid matter, and there is no atmosphere around that planet for the light to pass through. In the case of Mars, most of the light is radiated by the solid matter, the atmosphere being very rare, and the planet being weakly energetic, probably no variations of any consequence occur in the density of the atmosphere.

And further, since the planets twinkle only occasionally, and considering their twinkling to be principally due to inequalities in the density of the earth's atmosphere, then only occasionally docs the earth's atmosphere have such inequalities, and, reasoning by analogy, it would be only occasionally that the atmosphere of another planet would have such inequalities in its density as would cause twinkling, so that if all the light of a planet were transmitted through its atmosphere it would twinkle only occasionally.

But a fixed star, being a sun, is continually in a high state of energy, and bodies of gas are being ejected at numerous points, forming protuberances, which give to the chromosphere a very irregular form, and on account of the ever disturbed condition of the chromosphere, its density must be very varied. And the fixed stars have axial rotation, so that the light which reaches the eye from such a star at succeeding moments has come through different portions of the star's

chromosphere, and owing to the inequalities in the density of the chromosphere, and to the irregularities in its form, the light is differently refracted through different portions, causing fluctuations in the light which reaches the eye.

Twinkling usually consists in the drawing in and shooting out of the star-points, and such twinkling is probably the result of interims between the arrivals in the eye of edge portions of densits from the same portion of the limb of the twinkling body, for, as we have seen, star-points are evidently due to edgetal deflection in the eye.

Owing to the great distances of the fixed stars, the densitic edges in such a star's light must be quite a distance apart, while, owing to the comparative nearness of the planets, the densitic edges in a planet's light must be much closer together, so close together that ordinarily there are no appreciable interruptions in their arrival in the eye.

The inequalities and irregularities in the star's chromosphere cause the edge portions

of the densits of its light to be refracted out of their true courses, so that they reach the eye irregularly, and the star-points do not, therefore, come and go regularly.

Inequalities in the density or moisture of the earth's atmosphere also cause the edge portions of the densits, of a planet's light, as well as of a fixed star's light, to be refracted into and out of the line of vision, and when this occurs it causes irregularity in the arrival of the edge portions in the eye, and this is probably the principal cause of the twinkling of the planets, increasing the twinkling of the fixed stars also.

The densits whose edge portions are so refracted come from the limb of the twinkling body, and in the case of a planet, which presents a face of such extent that the limb is distinguishable (which is not so with a fixed star), the twinkling may appear to be a phenomenon of the limb only (63).

White stars twinkle most, and red stars twinkle least, which may be explained by saying that the light of a white star probably

has the highest polymannerism, while the light of a red star probably has the lowest, and since the number of densitic systems depends largely on the polymannerism, the number of densitic edges in the light depends largely on the polymannerism also.

Twinkling is rated by the number of scintillations per minute, the greater the number, the more the star twinkles, so that the more numerous the densitic edges in a star's light (if not so numerous as to prevent twinkling entirely), the more rapid the star twinkles. Hence the difference in the twinkling of white and red stars.

According to Montigny's observations, the greater the number of dark lines in a star's spectrum, the less it twinkles; the reason evidently being that the greater the number of dark lines, the greater the number of densitic systems eliminated from the star's photospheric light, and, consequently, the fewer the densitic edges in the remaining light.

Faint stars twinkle less than brilliant ones.

It will be noticed that the faint stars have very few star-points. The faintness may be due to the great distance of the star, or it may be due to the smallness of the star. If it is due to great distance, the densitic edges in the star's light are farther apart than they would be at shorter distances, because of the greater expanse over which the light is spread out, and so of course the twinkling is less. If it is due to smallness of the star, the densitic edges in the star's light are fewer than they would be if the star were larger, because the number of densitic systems in the light of a body depends on the number of particles of matter engaged in the generation of the light, and since the edges are fewer, they must be farther apart than they would be if they were more numerous, and so of course the twinkling is less.

NOTES

(1) The word Energial is used herein as the adjective of the noun Energy, meaning, of, by, caused by, or pertaining to, energy; as, energial propagation, meaning, the propagation of energy; energial actuation, meaning, actuation by energy.

(2) The term Unparticulate is from the Latin word Particula, a particle, and means, not in the form of particles. The noun, signifying the state of being unparticulate, would be Unparticulation.

The term Particulate, meaning, in the form of particles, is now in use: see Soddy's *Radioactivity*.

(3) Den′sit. Adjective, Densit′ic (-al).

The movements by which densits are caused, considered either as to a single system of densits or as to all the densitic systems in the energy of a body, as in the solar energy, may be called Densition, as, we may refer to the movements in the ether and atmosphere whereby the solar energy is transmitted to the earth as densition.

Adjective, Densitional; as, densitional movements.

The expression Densitional Normalization relates to the maintenance of the state wherein the densitional movements are always normal to the densits, except in polarized densition.

(4) Having two qualities, positive and negative.

(5) "The rays we have heretofore been considering consist of positively charged particles travelling in the direction in which such particles would be moved by the

electric field in the discharge tube. In addition to these there is another system of rays travelling in the opposite direction. By far the larger portion of these rays are cathode rays, *i. e.*, negatively charged corpuscles moving with great velocity. . . . The fact that these rays travel with high velocities away from the cathode and thus in the opposite direction to the electric forces acting upon them makes their investigation a matter of considerable interest." *Rays of Positive Electricity*, by Sir J. J. Thomson, page 75.

(6) "The heat possessed by a body is explained as being the energy possessed by it in virtue of the motion of its particles. Just as a swarm of insects may remain nearly at the same spot while each individual insect is energetically bustling about, so a warm body is conceived of as an aggregation of particles which are in active motion, while the mass as a whole has no motion." Daniell's *Principles of Physics*, page 48.

(7) *The Theory of Light*, by Preston, page 79.

(8) Densitic curvature is the spherical curvature of the densits. As the densits proceed they expand, and the curvature becomes that of larger spheres, that is, it decreases.

(9) Densitic angularity is the angularity between the intersecting densits of different systems.

(10) *Radioactive Transformations*, by Rutherford, page 16.

(11) *Radioactivity*, by Soddy, page 115.

(12) The action by which energy is generated and transmitted may be called Energial Action.

(13) Inasmuch as we commonly look upon energy which produces chemical effects as a distinct form, making frequent reference to it as a form of energy, chemical energy, it is fitting that it should be given a name, and the author offers the name Chemicity. Adjective, Chemic or Chemical.

(14) Energial character is the character or quality of

atomic matter on which depends the characteristic energy of any particular kind of matter, and on which depends its peculiar energizability. Since matter becomes energetic in different manners and methods of energy under different conditions, we may say that its energial character changes as the conditions to which the matter is subject change.

The word Energitia may be used to mean energial character. Adjective, Energitial, as energitial modification.

(15) Adjective, Manner'ic (-al). The adverb is accented on the same syllable.

(16) Man'-nĕ-ry. Adjective, Man-nĕ'-rial. The adverb is accented on the same syllable as the adjective.

(17) The present theory is that the skylight is sunlight reflected by particles of atmospheric dust; it being thought that, owing to the smallness of the particles, only the blue light is reflected. Hastings and Beach's *General Physics*, page 680.

(18) In this connection Professor Tait, in his book on *Heat*, page 250, says: "This prepares us to see that the radiation from a body depends upon itself alone (*i. e.* upon its constitution, its temperature, the nature of its surface, etc.), and therefore that the equilibrium of temperature which ultimately obtains among bodies within an enclosure which contains no source of heat, is arrived at, not by the warmer bodies alone radiating to the colder, but by all the bodies simultaneously radiating, each to an amount depending on its own nature, surface-conditions, and temperature. Also that equilibrium, once attained, is maintained by the same process. This is called the Theory of Exchanges."

(19) The present theory is that the lights of the moon and planets are reflected sunlight.

(20) Professor Rowland, to whom the identification of the lines of the solar spectrum is principally due, counted about 14,200 lines in the spectrum of the sun, and about

5,700 in the ultraviolet field, and the thirty-six elements so far determined are represented by less than one third of these lines.

(21) Abbot, in his book, *The Sun*, page 98, says: "The lines themselves are not to be regarded as dark except by contrast. If seen against a black ground they would be dazzlingly bright." And see note on page 81 of Young's book, *The Sun*.

(22) "Even under the conditions of our terrestrial laboratories we find cases where when several gases and vapours are mingled at a high temperature, certain ones only of those present appear in the spectrum of the mixture, the others giving no indication of their presence. Then, too, it is now certain that the same substance under different conditions may give two or more widely different spectra." *The Sun*, by Professor Young, page 89.

(23) The term Energial Motion means, motion of a particle or body of matter resulting from its own internal energy, under energizement by energy of other matter, the actuating energy acting in the kinetic method in the particle or body.

(24) The term Kinetic Energy means, the transatomic, uniqualital energy which causes motion of the particles and bodies in which it occurs.

(25) For various theories of gravity see article by William B. Taylor in the *Report* of the Smithsonian Institution for the year 1876, pages 205 to 282. Newton's ideas as to the nature of gravity are there set forth.

Several other theories have been advanced since, among which is a theory, advocated by Sir J. J. Thomson and others, that gravity might be due to a difference in the action of the two qualities of electricity, the supposition being that the attractive force might be stronger than the repulsive.

Maxwell supposed that gravity might be accounted for by his electromagnetic theory, and Osborne Reynolds

attempts to account for it by his theory of the granular structure of matter.

(26) In Warren's *Recreations in Astronomy* gravity is referred to as the Will of God.

(27) There may be some exceptions. The revolution of the outermost satellites of some of the planets in a direction contrary to the direction of revolution of all other bodies of the solar system is readily explainable on this supposition. The matter of which such bodies are composed may be entirely different from any matter of which we know.

It would not be remarkable that some matter might be energized kinetically by the positive quality of gravity.

(28) It is probably the common idea that electricity is energy—see article on Electricity by Charles P. Steinmetz in *Encyclopedia Americana.* Some consider electricity to be a potentiality in the matter of the medium (the ether), and some even consider it to be matter—see Barker's *Physics*, page 538.

Faraday advanced the idea that electrification is due to a strained condition of the ethereal medium around an electrified body, and it was this idea that gave rise to Maxwell's electromagnetic theory, which supposes that electrification is an action in the medium whereby the potentiality is converted into energy, which action is supposed to be a stress consisting of tension and pressure, as to which Maxwell in his work on *Magnetism and Electricity*, vol. i., page 63, says: "From the hypothesis that electric action is not a direct action between bodies at a distance, but is exerted by means of the medium between the bodies, we have deduced that this medium must be in a state of stress. We have also ascertained the character of the stress, and compared it with the stresses which may occur in solid bodies. Along the lines of force there is tension, and perpendicular to them there is pressure, the numerical magnitude of these forces being equal."

Under that theory it is supposed that the disturbances in the ether produce "waves," and it was to establish this that Hertz performed his experiments.

It is needless to say that Hertz's experiments, or any other experiments, do not establish the theory of ethereal stresses. There is no evidence whatever of any such stresses, and it is impossible to conceive, and no one has yet been able to conceive, how energial motion can be produced by such stresses, and unless the modus operandi of a theory can be explained, the theory is very unsatisfactory, to say the least.

When it is admitted that energial motion is caused by the energy of the moving matter, the theory of stresses becomes superfluous.

(29) It is the common opinion that electricity is transmitted, both through media and along conductors, as "waves," this having been established by the experiments of Hertz.

In his experiments Hertz used an electric oscillator, in which the charges oscillated rapidly across the spark gap, and he used a sparking device, commonly referred to as the resonator, with which to detect the energy in the air.

With the oscillator at one end of a long room and a large sheet of zinc at the other end, upon carrying the resonator between the two, he found that there were places where the sparking of the resonator showed maximum intensity, with places between where there was no sparking. The distance between the points of maximum intensity was about six feet.

Experiments made by others show that the maximum and minimum effects occur at different points with resonators of different sizes.

Hertz concluded that the dead places were due to interference between the "waves" from the oscillator and those reflected from the zinc.

Hertz also showed that the electric "waves" are re-

flectible, and that they may be brought to a focus by concave reflectors, and also that they are refrangible, being refracted by a prism of pitch.

(30) *Rays of Positive Electricity*, by Sir J. J. Thomson, page 7.

(31) One theory at present is that the "waves" are reflected back and forth between the earth and a rare stratum of air above. Another theory (Fessenden's theory) is that the hemispherical "waves" slide around the surface of the earth.

(32) As to the conduction of electricity, Professor Watson, in his *Text Book of Physics*, page 673, says: "As far as we are able to tell, however, the only thing that does pass is energy, this energy being in the form we call electricity, but of the nature of which we are entirely ignorant; and so far from the energy being transmitted by the wire through which the current is flowing, the accepted belief nowadays is that the energy is really transmitted by the insulating dielectric which surrounds the wire, and that the function of the wire is to direct the flow of energy."

(33) See photographs of lightning in the *New International Encyclopedia*, in the article on lightning.

(34) See Crew's *General Physics*, page 444, and Southall's *Principles and Methods of Geometrical Optics*, page 16.

(35) There is need of a name for the colour energy which gives vision of objects, and the author offers the name Analight (Ana, back), being the light which comes back from matter on which light falls.

(36) The pieces of glass may be about four inches square and a quarter of an inch thick, but it may be easier to get them together if one is an eighth of an inch thick. In putting the glasses together start the edge of one over the edge of the other, pressing the two together tightly with the thumbs and forefingers, and gradually slip one over the other. When they have gripped firmly and cannot be easily slipped over each other, place one edge

on the knee and hammer the other edge with the palm of the hand, pressing the glasses together tightly at the point of contact. When so in contact the glasses cling together with great force, under atmospheric pressure, and will remain until forcibly taken apart.

The author has obtained perfect contacts of several square inches in area.

Newton's rings occur around the place of contact, and an excellent opportunity is afforded for studying them.

Attention is called to the innermost ring, the white portion to be seen at the contact boundary. It has the appearance of an impalpable powder, and by turning one glass on the other slightly the whiteness may be broken up to some extent, being drawn out into little tongues. The explanation probably is that the atoms of the air are energized centroatomically.

A powerful microscope might reveal something as to the atoms.

(37) Wood's *Physical Optics*, page 40.

(38) *The Theory of Light*, by Preston, page 80.

(39) The particular frame of energy in a particle or body of matter at any particular time, depending on the quality of the energy, the relation of the qualities as to preponderance, the intensity, the mannerism, and the method, may be called the energial Status of the matter.

(40) Daniell's *Principles of Physics*, page 485.

(41) From the Greek word Chloros, greenish yellow. This colour occurs in the spectrum after the yellow, being seen only when the green is absent. It is a greenish yellow, the yellow of the spectrum blending into it. It may be seen by looking through the prism at the lower edge of a sheet of white paper on a black background.

(42) From the Greek word Glaukos, greenish blue or bluish grey. This colour occurs in the spectrum before the blue, being seen only when the green is absent. It is a light greenish blue or grey, blending into the blue. It may

be seen by looking through the prism at the upper edge of a sheet of white paper on a black background. The word is now in use.

(43) This classification as to quality has been made after a careful study of certain phenomena indicative of the qualities of the two sets of colours. The experiments of Sir J. J. Thomson are also determinative of the classification, as shown by the following: "The contrast between the colour of light due to the positive rays and that due to the cathode [negative] rays is, when some gases are in the tube, exceedingly striking. Of all the gases I have tried for this purpose neon gives the most striking results, for with this gas the light due to the positive rays is a most gorgeous red, while that due to the cathode rays is a pale blue; with helium the positive rays give reddish light, while that due to the cathode rays is green. . . . With German glass the positive and cathode rays both produce a greenish phosphorescence, though the greens are of different shades. With some substances the contrast is much more striking, for example, with fused lithium chloride the phosphorescence produced by the positive rays is an intense red . . . the phosphorescence due to the cathode rays is a pale blue." Thomson's *Rays of Positive Electricity*, pages 2 and 3.

(44) Wood's *Physical Optics*, page 10.

(45) The fact that a mixture of yellow and blue paints gives green instead of white is commonly explained by saying that the blue matter absorbs the red, orange, and yellow out of the white light, and that the yellow matter absorbs the blue, indigo, and violet out of the white light, only the green being left. Watson's *Text Book of Physics*, page 567.

If this were true there could not be any yellow and blue matter under white light, because, since the yellow matter would not absorb the green light, the yellow matter would always be greenish yellow, and, since the blue matter

would not absorb the green light, the blue matter would always be greenish blue.

(46) Densitic incidence is the impinging of densits on the surface of a body of matter, and as to any part of a densit the incidence is either normal or angular, being normal when the normal line to the surface at the point of incidence is parallel with the line of propagation of the part of the densit having incidence at such point, and being angular when such lines are not parallel. As to the eye, densitic incidence refers especially to the part of the densit reaching the eye first.

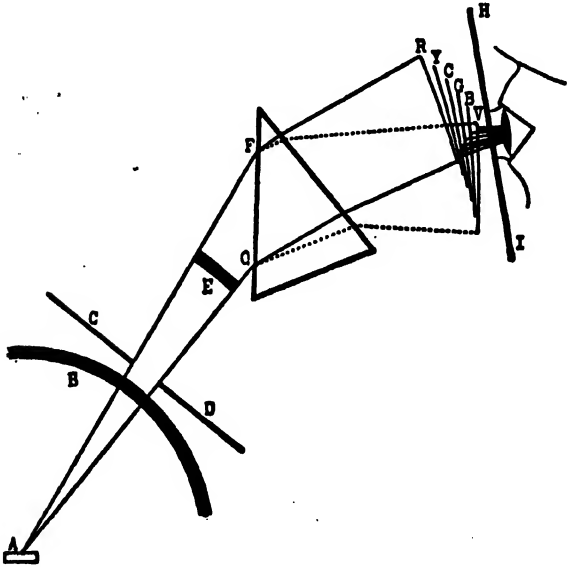
(47) In the spectrum produced on the screen or piece of paper by the sunlight, as in the experiment described, the blue-violet set of colours is on the side corresponding to the base of the prism, and the red-yellow set is on the side corresponding to the apex of the prism, while when we look through the prism at a strip of white paper the blue-violet set, as we have seen, is on the side corresponding to the apex of the prism, and the red-yellow set is on the side corresponding to the base.

This difference in the positions of the colours in the two cases is due to the difference in the densitic incidence on the eye, the hemispherical densits emanating from the points in the paper having different incidence than the densitic segments which reach the eye directly from the prism when looking through it.

Attention is called to this, because here we have additional proof of the theory of energizement.

In Drawing D let A represent a luminous body from which white light is emanating, and let the arcs at B represent a system of densits of white light generated at a point in the body A, which system, we will suppose, includes a red, yellow, chloro, glaucous, blue, and a violet densit. Let C and D be obstructions, between which a small segment of the light may pass, in order that we may have segments of definite size to deal with, and let the arcs

at E represent the densitic segments, which segments will impinge on the prism between the points F and G. The solid straight lines through and beyond the prism are bournal lines (see note 56) of the red densit, and the dotted



Drawing D.

straight lines are bournal lines of the violet densit, the courses of the other densits being between those of the red and violet. Let the curves R, Y, C, G, B, and V (being the initial letters of the names of the colours) represent the segments after transmission through the prism.

It will be seen that there is angularity between the segments, and it will be seen that they all overlap between

the lower edge of the red segment and the upper edge of the violet segment, and yet the overlapping portions have different incidences on the eye, the straight lines from the segments to the eye being the lines of normal incidence. The colours would therefore be seen separately in the directions of the lines of normal incidence, as shown in the drawing, so that the violet would be the uppermost colour, corresponding to the apex of the prism, and the red would be the lowermost colour, corresponding to the base of the prism.

Now suppose a white screen, HI, to be placed so as to receive the densits. That portion of the screen on which portions of all the densits fall would be white, and on the screen the order of the colours would be the reverse of what it is when they are seen through the prism, the red on the screen corresponding to the apex of the prism, and the violet corresponding to the base.

The order in which the colours appear on the screen, and the fact that the colours on the screen can be seen from all directions in front of the screen, clearly show that the screen is energized centroatomically, and that a system of hemispherical densits is generated at each point in it where the colours appear.

(48) The motion of the radiometer is caused by the black matter being energized in the kinetic method, repulsively, by some of the manners. No light energy comes from the black matter, which is allomannerially energized, and the white matter is energized centroatomically by all the manners of the light.

(49) "And of these components—the one vibrating in the plane of free transmission, and the other at right angles to that plane—the former is transmitted, while the latter is extinguished by absorption, its energy being converted into heat." Daniell's *Principles of Physics*, page 516.

(50) As to this experiment Professor Edser, in his *Light for Students*, page 325, says: "This experiment proves that light does not consist of compressional or longitudinal waves, for it is inconceivable that a rotation of the second crystal about the direction of the ray, and therefore about the direction of vibration, should extinguish the light. After passing through the first crystal the light waves have acquired a one-sidedness with regard to the direction of the ray. It is now said to be polarized. We are therefore forced to conclude that the direction of displacement in the light wave is perpendicular to the direction of transmission."

(51) Edser's *Light for Students*, page 498.

(52) "A ray of light which only presents longitudinal vibrations must exhibit everywhere the same characters around its line of propagation. This view, therefore, since it is incapable of explaining the laterality of the polarized ray, must be unconditionally thrown aside." *The Nature of Light*, by Dr. Lommel, page 296.

(53) "In such cases the vibrations would rapidly run through a great variety of figures: circles, ellipses, figures-of-eight, and non-reentrant complex harmonic curves of every kind. This is the condition of common light." Daniell's *Principles of Physics*, page 515.

(54) Wood's *Physical Optics*, page 241.

(55) "By increasing the number of plates we can increase the intensity of the reflected polarized light, and consequently the completeness of the polarization of the transmitted light, seven or eight being sufficient to give us nearly complete polarization in the transmitted, as well as in the reflected beams." Wood's *Physical Optics*, page 234.

(56) The edges of a system of segmented densits proceed within certain bounds, that is, the densitic field has a definite boundary, which may be called the densitic Bourn. When the densits are hemispherical the bourn is a plane.

In the case of a round beam of light with parallel sides the bourn is cylindrical. If the beam is conical, either diverging or converging, the bourn is conical accordingly, and so on. The densitic bourn may be external or internal. The bourn of light which passes through a hole is external, and the bourn of light which passes by the sides of an object, such as a flying bird, is internal.

The lines which are used in drawings to represent densitic bourns may be called Bournal Lines.

(57) Professor Maclaurin, in his work, *The Theory of Light*, Part I., page 63, refers to a "layer of transition" at the boundary between two media.

(58) Diffraction bands are commonly supposed to be due to interference between Huygens' hypothetical wavelets, as to which Professor Wood, in his *Physical Optics*, page 151, says: "He [Fresnel] was the first to give the true explanation of the phenomenon, regarding the maxima and minima [of light] as the result of the interference of the hypothetical secondary wavelets diverging in all directions from these portions of the wave-front not blocked off by the opaque screen."

(59) In the following experiment with the same apparatus lines of densitic vitiation, due to interference between parts of light, may be very nicely seen:

Make a double slit in the paint on the glass by drawing a sharp pointed pen across the paint, pressing down very gently so that the points of the pen are but slightly spread apart, barely separated.

Upon looking through this double slit at the candle flame from a distance of six or eight feet, a number (about eight) of parallel, vertical dark lines will be seen extending through the flame, being lines of densitic vitiation.

Lateral stripes may also be seen at either side.

By turning the glass so that the slit is oblique, it will be seen that the lines of vitiation remain vertical and parallel with the flame, which, of course, is to be expected.

When an incandescent electric light is looked at through the double slit, lines of vitiation will be seen along each filament, and it will be seen that the lines are much finer and closer together than those in the candle light, which evidently indicates that the densits in the electric light are more numerous than in the candle light.

(60) Tyndall's *Light and Electricity*, page 358.
(61) Daniell's *Principles of Physics*, page 550.
(62) Wood's *Physical Optics*, page 75.
(63) Daniell's *Principles of Physics*, page 550.